THE ENGINEER.

# British Machine Tools at the Olympia Exhibition.

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IN 1864, reviewing the proceedings at the summer meeting of the Institution of Mechanical Engineers, we singled out a paper on the history of machine tool improvement as being without doubt the best of the session. We favoured it not because it opened a wide field for discussion—"for no paper on machine tools," we wrote, "can do this"—but because of the amount of suggestive matter which it contained. Nothing, perhaps, better than the parenthetical remark could illustrate the great progress made during the past sixty years in the design, construction and application of machine tools and the change that has been wrought in the engineer's attitude towards them. They are no longer, as they were generally in those days, mere adjuncts and accessories of the skilled craftsman. They are to-day in very large measure craftsman and tool combined.

A review of the machine tools now being shown at Olympia in the Exhibition organised by the Machine Tool Trades Association emphasises very strongly the extent to which the control of the output as regards both quantity and quality, has been taken out of the operator's hands and made more or less automatic. To-day it might be said, with almost complete respect for truth, that, given a good equipment of modern machine tools, the manufacturing engineer is all but independent of the skill or lack of it of his workpeople.

No longer either is it true that machine tools afford no field for discussion. On the contrary, there is probably no subject in the whole region of engineering which provides a better opportunity for wide-reaching instructive debate, nor is there one likely to interest a bigger circle. In spite of the progress made in the direction of eliminating the personal influence of the operator, design and methods of working are still far from being stereotyped in many important respects and in a multitude of details. It will be found, for instance, that some makers still hold strongly to the single purpose machine, which was developed to a large extent under the conditions of the war, while others maintain equally strongly their belief in the universal type of machine, which is neither a lathe nor a boring mill, a driller nor a milling machine, nor yet a gear wheel cutter, but each and all in turn as required. From such a fundamental cleavage of outlook as is thus indicated, we could pass in review many subjects for debate down to relatively small matters, such as the extent to which it is desirable to replace stepped pulleys by change gearing. How marked division of opinion still is among machine-tool designers in some details is admirably illustrated by the fact that certain of the exhibitors at Olympia call special attention to the feature that the speed gearing of their machines can be changed while the machines are running, while others equally prominently emphasise the steps they have taken to prevent the gearing being changed except when the drive is stopped.

In compiling the following descriptions of some of the exhibits we have restricted ourselves to British machine tools, adopting, for the immediate purpose at all events, the definition of a machine tool as an appliance for shaping and forming materials by removal with a cutting tool. It has been found quite impossible to include in the space available descriptions of all the principal British machine tools being exhibited. We have merely made a selection. Others will be found described in the pages of our ordinary issues, where also we are dealing with some of the many interesting tools of overseas origin which are on show and with a number of the exhibits which are not strictly machine tools.

### CHARLES CHURCHILL AND CO., LIMITED.

In addition to an interesting variety of machine tools of overseas origin, Charles Churchill and Co., Limited, of London, are showing four grinding machines made by the Churchill Machine Tool Company, Limited, of Manchester, among which is the spline shaft grinder illustrated in Fig. 1. For the production of hardened and ground spline shafts in motor car establishments Messrs. Churchill are opposed to the use of a formed wheel that will finish the sides and bottoms of the splines at one setting. They argue that as disc-shaped grinding wheels do not possess great cutting qualities on their sides, the formed wheel method of grinding spline shafts—and the same remark applies to the grinding of gear wheel teeth—

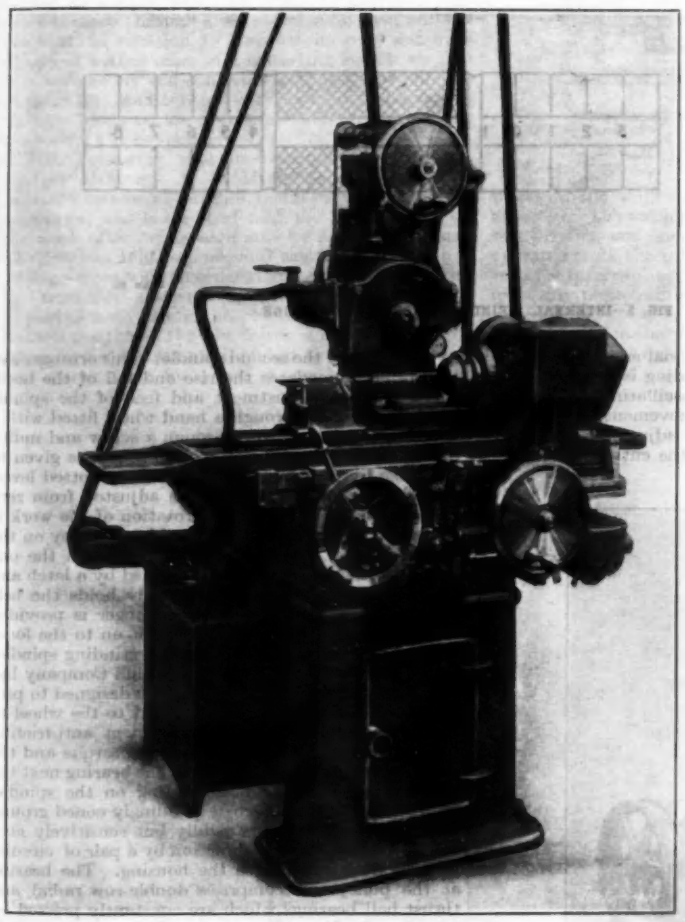

FIG. 1—SPLINE SHAFT GRINDING MACHINE—CHURCHILL

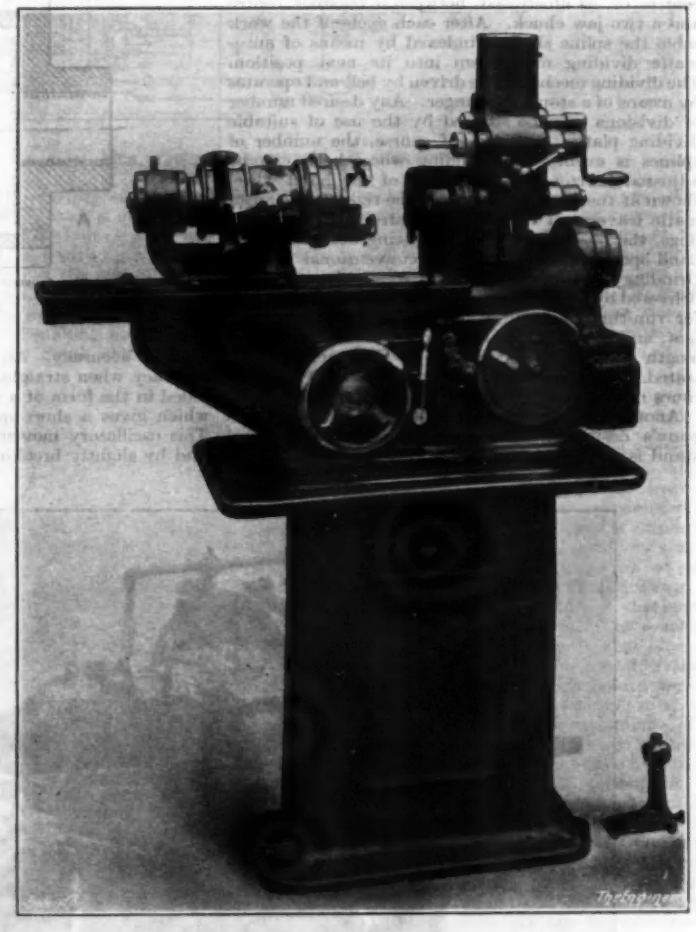

FIG. 2—INTERNAL GRINDING MACHINE—CHURCHILL

imposes a limit on the production that can be obtained. The method used in the machine illustrated makes use only of the periphery of the wheels. For the first operation on a six-spline shaft two wheels—see Fig. 3—are fixed on the spindle with a distance piece between them, and one side of two opposite splines are ground. The shaft is then indexed round, six stages in all completing the work. Before grinding is begun a diamond truing device is traversed across the peripheries of both wheels at one cut. A cam-operated fitting—also illustrated in Fig. 3—is provided for locating the spline shaft before grinding is begun. This fitting is also used when setting up the shaft for the second operation. That operation, as shown, consists of grinding the bottoms of the splines by means of a disc wheel, the periphery of which has previously been shaped to suit the curvature of the bottom. The machine illustrated accommodates spline shafts up to 18in. in overall length, but exactly

the same principles are applicable to machines measuring up to 5ft. or more between centres. The general design consists of a box body, a flat table to which an automatic reciprocating motion can be communicated, and an upright carrying the grinding head. The spindle can be adjusted vertically through a distance of 3in. under the control of a graduated hand wheel at the top of the upright. The hand wheel referred to is provided with dead stop mechanism. In order to eliminate lost motion in the feed of the grinding wheel the head is heavily counterbalanced in such a way that when the spindle is being lowered the balance weight has to be pulled against continuously. The spline shaft can be held either between centres or, as illustrated, between a tailstock centre and a two-jaw chuck. After each cycle of the work table the spline shaft is indexed by means of automatic dividing mechanism into its next position. The dividing mechanism is driven by belt and operates by means of a stop and plunger. Any desired number of divisions may be secured by the use of suitable dividing plates, provided, of course, the number of splines is even. The grinding wheel head can be adjusted horizontally by means of the hand wheel shown at the front and towards the right. The automatic traverse of the table is controlled by tripping dogs, the position of the table being determined by hand-operated mechanism of conventional design. Grinding is performed under a supply of water delivered by a pump from a tank. The grinding wheels for run-through splines are 8in. in diameter when new, and with wheels of this size a maximum spline length of 10in. can be ground on the machine illustrated. On non-run-through spline shafts it is sometimes necessary to use slightly smaller wheels.

Another tool of the Churchill Machine Tool Company's design and manufacture exhibited on this stand is the 6in. by 18in. heavy plain grinder illustrated in Fig. 4. This machine closely resembles a familiar design previously produced by the firm, with the exception that it has been shortened with respect to the length that can be admitted and increased as regards the size of wheel employed. The object of these changes was to secure a machine that would give the maximum production on work of medium length such as motor car gear-box shafts and stub axles. The wheel head is of a very heavy pattern and carries a wheel 18in. in diameter and normally 2in. wide, although its width may be as much as 4in. if required. The spindle, if desired, may be fitted with two wheels of different diameter so as to permit form grinding to be carried out by the straight-in feeding method. A dead stop wheel truing device is employed in this connection, which brings the wheels accurately to their respective sizes and enables the grinding to be carried out to very close limits of accuracy. An additional assistance towards accuracy when straight-in feeding is adopted is provided in the form of a table oscillating arrangement, which gives a short quick movement to the table. This oscillatory movement is adjustable in amount, and by slightly breaking up the cut of the grinding wheel preserves the truth of the grinding wheel face and therefore assists towards the rapid production of parallel work. The wheel head is fitted with a quick hand motion for rapidly moving the wheel from large to small or from small to large diameters. The traverse of the table and the rotation of the work are controlled through a gear-box which gives four rotary speeds for each traversing speed. Although the rotary and traversing speeds are independently controlled, both may be simultaneously stopped through the agency of a single lever. A forged steel guard is provided for the wheel to protect the operator and the work.

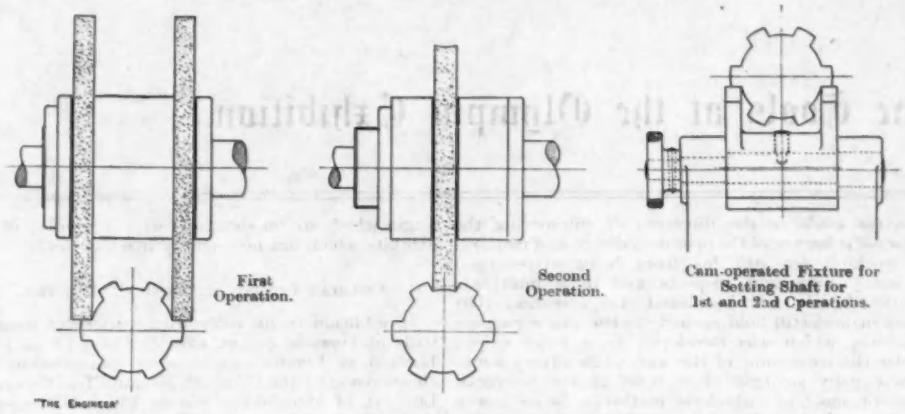


FIG. 3—GRINDING A SIX SPLINE SHAFT

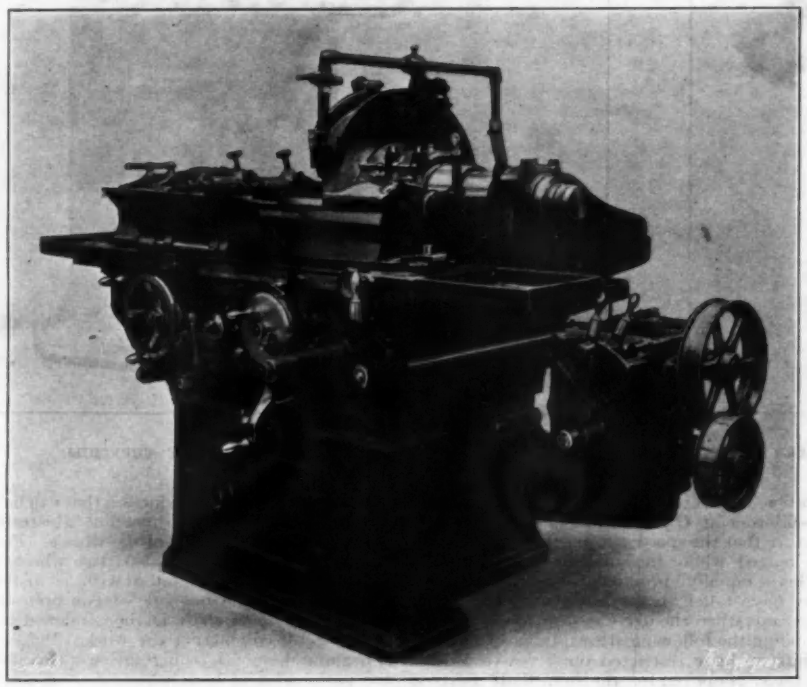

FIG. 4—HEAVY PLAIN GRINDING MACHINE—CHURCHILL

In precision internal grinding it is frequently found that the time spent in setting up the work and gauging it is greater than that occupied by the actual grinding operation. To reduce the non-productive time requires generally special study of the part being ground, but a Churchill internal grinding machine shown at the Exhibition and illustrated in Fig. 2 should be found adaptable to various forms of internal work. An example of the work for which this machine is fitted is shown at A in Fig. 5, which represents a motor car pinion of which the inner face and the parallel bore have to be ground. The work is held in a two-jaw chuck, quick and accurate location being secured by means of a taper plug which is subsequently withdrawn. The grinding wheel head carries two spindles and can be moved vertically by means of a rack and pinion, the movement in each direction being controlled by a dead stop. The first operation in the case of the example illustrated is to grind the bore by means of the wheel on the upper spindle. Thereafter the head is raised and the second wheel brought into action on the internal face. We are informed that out of a total time of seventy seconds the non-productive time amounts with this machine to twenty-two seconds, namely, ten seconds for positioning and fixing the work in the chuck, six seconds for changing the spindles, and six seconds for removing the work. Both spindles are driven by the same endless belt from a pulley at the back of the head. The belt, after passing over the pulley of the top spindle, is taken back to a jockey pulley and then led forward to the pulley of the second spindle. This arrangement readily accommodates the rise and fall of the head. The transverse adjustment and feed of the spindle head are secured through a hand wheel fitted with a dead stop and operating through a screw and multiplying lever. A reciprocatory movement is given to the table by means of a cam and a tee-slotted lever, whereby the movement may be adjusted from zero to a maximum of 1¼in. The rotation of the work is controlled by means of a fast and loose pulley on the chuck spindle, the belt being moved from the one pulley to the other by a fork operated by a latch and spring plunger. The latch normally holds the belt on the fast pulley; the spring plunger is provided for the purpose of throwing the belt on to the loose pulley and retaining it there. The grinding spindles are of a new type, which the Churchill Company has now adopted as standard. They are designed to provide a solid, adjustable bearing next to the wheel to take the grinding load and an efficient anti-friction bearing at the pulley end to take the torque and the pull communicated by the belt. The bearing next the wheel consists of a conical seating on the spindle, on which is mounted a correspondingly coned ground bronze bearing which is rigidly but sensitively controlled in the endwise direction by a pair of circular knurled nuts external to the housing. The bearing at the pulley end comprises double-row radial and thrust ball bearings which are constantly pressed by a spring firmly against a shoulder on the grinding spindle.

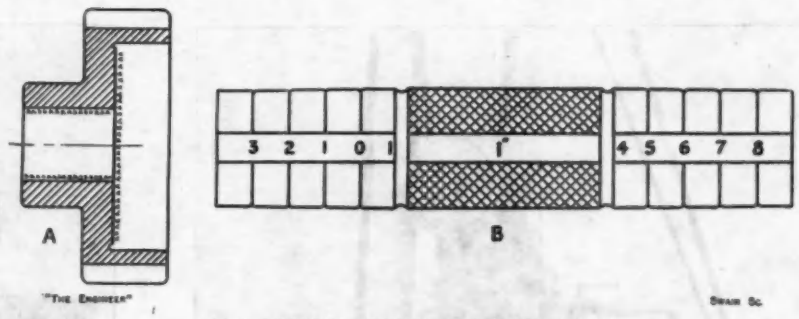


FIG. 5—INTERNAL GRINDING—WORK AND GAUGE

It will readily be appreciated that with a machine of the above design setting up time should be capable of considerable reduction. The other source of non-productive expenditure is the time spent in gauging the work. To facilitate and expedite this operation the Churchill Company has produced the form of taper gauge shown at B in Fig. 5. Both ends of this gauge are tapered, the cone at one end continuing the taper of the cone at the other, the smallest diameter being towards the right in our engraving, and each successive ring therefrom representing an increment of 0.001in. in the diameter. By means of this gauge the operator can quickly determine at any stage how much material has still to be removed. Having determined the amount, he sets his micrometer feed wheel and dead stop to suit, and is thus enabled to dispense with intermediate gauging.

### E. G. HERBERT, LIMITED.

A wide range of sawing machines and sawing appliances dominates the stand of Edward G. Herbert,

Limited, Levenshulme, Manchester. The machines shown range from the simple to the complex. An example of the first class is the portable hand-operated rail-sawing machine, illustrated in Fig. 6. This machine can be set up and operated by one man, and, according to the makers, is capable of sawing through a 75 lb. rail in 25 min., or a standard 7in by 7in. tramway rail in 35 min. The frame, it will be noticed, is fixed in position by an adjustable foot at one end and a set screw and serrated jaw towards the other. In a more elaborate form this machine is made to be driven by an attached electric motor,

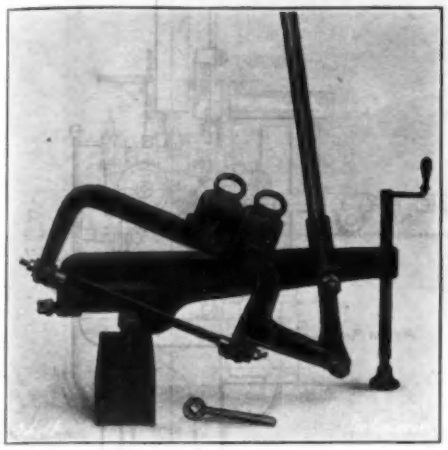

FIG. 6—RAIL SAW—E. G. HERBERT

taking its supply from the tramway current. The drive is made through a worm-reducing gear, and the machine, in addition to carrying its own motor, is equipped with a main and a starting switch, so that it is completely self-contained. It rests on four adjustable feet, and is fitted with mechanism for raising the saw blade on the return stroke. When working it absorbs ¾ horse-power.

The jig-sawing machine illustrated in Fig 7 is another of Messrs. E. G. Herbert's exhibits. It is intended for sawing out dies, metal patterns and sheet templates, and is supplied with file holders, so that the work after being sawn may be finished by filing. The table is 15in. square, and can be tilted through 10 deg. either way, in order that dies may be cut with the necessary clearance. An adjustable work stay is provided to secure the object to be sawn in any desired position. The saw frame is reciprocated by a crank and connecting-rod, and at the top is provided with a magazine for a coil of saw blade measuring

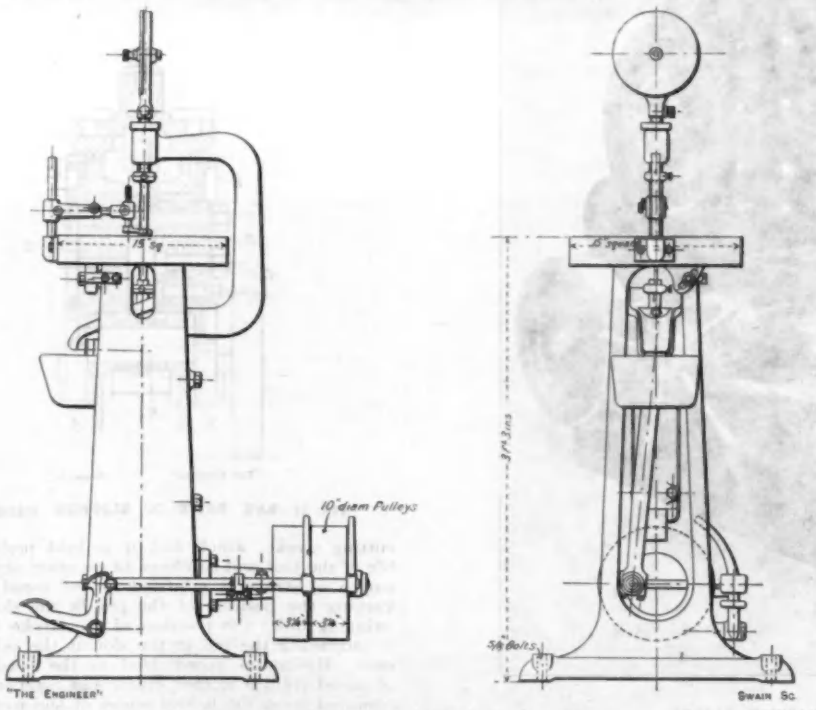


FIG. 7—JIG SAWING MACHINE—E. G. HERBERT

when unwound from 25ft. to 50ft. in length. The saw is set in the holders with a rake of about ¼in. to increase the cutting action, and to give the blade clearance on the up stroke. Adjustment of the stroke is effected at the crank pin, and covers the range from zero to 4in. The main slide is square and moves in a long bearing, which is adjustable for wear. A shoot and box are provided for the reception of the cuttings.

The large sawing machine illustrated in Fig. 8 was originally designed by Messrs. E. G. Herbert for the Admiralty for the purpose of sawing oil-hardened gun steel billets up to 26in. square in section. It is provided with an automatic lift to the saw frame on the return stroke, and with an oil dashpot to prevent the sudden drop of the frame when the work has been sawn through. At the front end of the machine a handle operating through worm gearing enables the frame to be raised or lowered with ease, while at the rear end a spring counterbalance arrangement, with a dial indicator, permits the pressure exerted by the

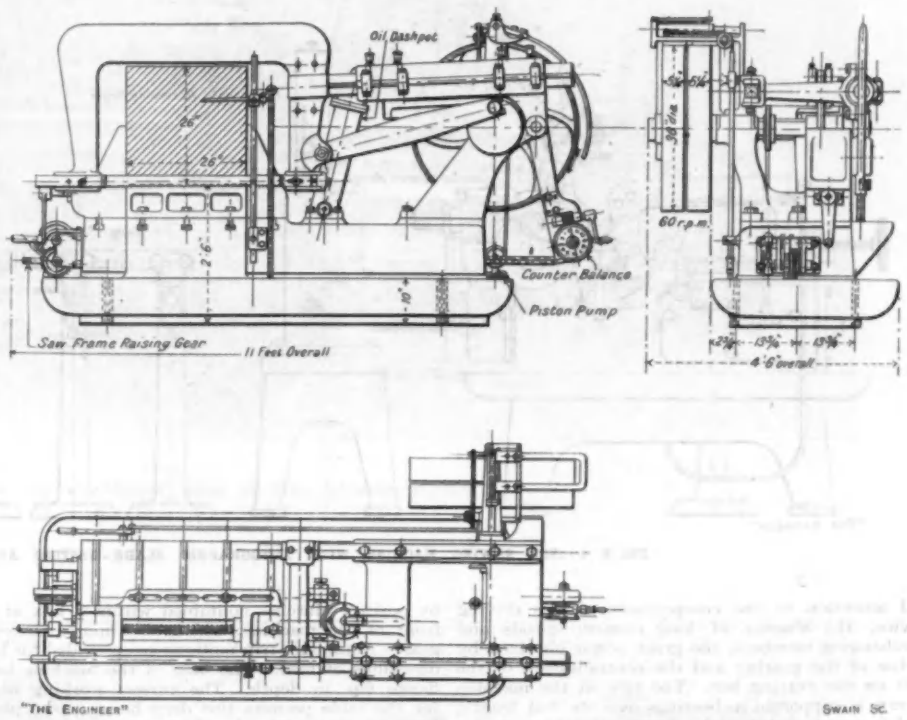


FIG. 8—26-INCH SAWING MACHINE—E. G. HERBERT

blade on the work during the cutting stroke to be adjusted. The machine, as illustrated, is arranged for belt driving, and is equipped with belt-striking gear, operated from the front end, and with an adjustable stop for interrupting the drive at the end of the cut or at any predetermined depth. The work is held in a screw vice, which may be swivelled on the tee-slotted bed for the purpose of making angular cuts. A piston pump driven off the crank shaft supplies suds to the saw.

In Fig. 9 we give a drawing of another form of sawing machine on Messrs. E. G. Herbert's stand. This machine is of particular interest, because it has attached to it an autographic recording apparatus for use in connection with the testing of saw blades. It is also worthy of notice on account of its automatic action. The machine can accommodate rounds, squares, angles and other sections up to 6in. by 6in. and 18ft. in length, and will cut them up automatically into pieces 2ft. or less long. With the gauge length set, the dial shown in the engraving is turned until the pointer is opposite the number of pieces required. The machine will then proceed to cut the stock to the gauge length, automatically feeding the material forward after each piece is severed until the set number of pieces have been sawn off, whereupon it stops. If the dial be set to the letter R, standing for "repeat," the machine will continue working until the whole of the material has been sawn into pieces of the gauge length. Moreover, if the saw blade breaks, the machine will automatically stop. Apart from the automatic feeding details, the construction of the machine follows closely the design of that illustrated in Fig. 8. As a saw blade testing device, the machine may be set to cut thin slices off a mild steel bar, 4in. in diameter, at a speed of 125 strokes per minute. The autographic apparatus draws a stepped diagram, each step representing a slice of the bar and its height indicating the number of strokes taken by the saw to effect the cut.

### THE BUTLER MACHINE TOOL COMPANY, LIMITED.

Slotting, planing and shaping machines are being shown by the Butler Machine Tool Company, Limited, of Halifax. Of the first named type we illustrate an example in Fig. 10. The machine represented is designated a puncher slotter, and has a stroke of 8/10in., that is to say, it can machine a maximum depth of work of 8in. with a clearance of 1in. at each end. The chief feature of interest in the design of this machine is perhaps to be found in the means provided for reciprocating the ram. These means fulfil three distinct functions, namely, that of communicating power to the tool on the downward stroke of the ram, of giving a quick return on the idle upstroke, and of permitting the length of stroke to be adjusted from zero to the maximum. The system adopted is the Butler patented excentric device, and is the standard practice of the firm in all its slotting machines. In Fig. 11 a diagram of the device in plan view is given. A 20 horse-power motor transmits power through a Fabroil pinion and spur reduction gearing on to a shaft carrying two pinions A A, one on each side of the machine column. These pinions mesh with two driving wheels B and C mounted on large-sized trunnions in the column. The driving wheels are bored excentrically and enclose excentric blocks D and E. A bolt F passes through both blocks and carries a bronze die operating within a slot in a lever fulcrumed on the shaft H and working between the driving wheels. A second bolt G extends through the excentric block D. By tightening these bolts the excentric blocks are securely locked within the driving wheels, the whole system then constituting a crank revolving on the trunnions of the driving wheels. An additional locking device is provided in the form of a pinion on the face of the driving wheel B, which meshes with teeth on the periphery of the excentric block D. By loosening the three nuts and pulling round the main driving shaft by applying force to the fly-wheel, the excentric blocks can be caused to slip within the driving wheels until the required stroke is indicated on a scale attached to the face of the driving wheel—see Fig. 10. It is claimed that the stroke can be changed from zero to the maximum value in less than 30 secs. The device gives a quick return movement to the ram by virtue of the movement of the crank pin

die in the slot of the lever. The short arm of the slotted lever is connected to the ram bolt—which bolt is adjustable vertically for positioning the stroke—by means of a forged steel swivel joint. In the machine illustrated in Fig. 10 the driving device differs slightly from that shown in Fig. 11, in that the slotted link is of the bell crank type oscillating on a pivot at the elbow, the slot being in the long arm of the lever and the short arm being connected to the ram by a forged rod. The makers call attention to the compactness of this driving device, the absence of long connecting-rods and overhanging members, the great power obtained by virtue of the gearing and the centralisation of the pull on the cutting bar. The ram in the machine shown is supported in bearings over its full length, and is counterbalanced by means of a lever and a weight, which is made adjustable on the lever in order that varying weights of toolholders may be compensated. The driving motor runs at constant speed, changes in the cutting speed of the tool being obtained by means of gearing within the trunk of the machine. A control panel supplied by Brookhirst Switchgear, Limited, of Chester, permits the ram to be "inched" and is provided with a push button stopping arrangement. Power feeds in the longitudinal and transverse directions can be communicated to the work table. Power for this purpose is taken from a cam groove on the face of the rear driving wheel C—Fig. 11—which cam communicates a constant throw to a main feed lever. This lever is in the form of a right-angled crank, one arm of which is slotted to provide a pin joint connection for a rod operating the feed screws through ratchet gearing. By varying the position of the pin in its slot the amount of feed applied at each stroke of the ram can be adjusted. The feed is applied just before the cut is begun, and the design is such that during its application the feed rods are in tension. The feeds are engaged and disengaged by positive clutches contained within a box at the front of the machine, which also houses reversing gear. Automatic trip motions are provided for both directions of feed. The base of the machine has a flange 6in. in depth. The correct working height for the table permits this deep flange to be placed below the ground level. Within the base a reservoir is provided for cutting lubricant, which is fed to the tool by means of a pump.

One of the shaping machines shown by the firm is illustrated in Fig. 12. This machine is of the double traversing head type, that is to say, it is fitted with two heads, each or either of which may be adjusted horizontally along the bed. It is claimed for this class of machine that it is very economical as regards labour costs and tool upkeep, and that it can deal with a wide range of work from light accurate machining to heavy cutting on steel forgings and castings. Each head has a separate driving motor, the main driving shaft for each head extending the full length of the bed, so that either head may work at any point along the bed. The longitudinal adjustment of the heads along the bed can be effected by quick power movement under the control of a handle A at the front of each headstock. Fine adjustments of the position are secured by means of a hand-operated counterbalanced ratchet handle B. At the back of the machine at each end of the bed a 15 brake horse-power electric motor running at a constant speed of 1050 revolutions per minute is situated, each motor driving a separate back shaft through an eight-speed change gear-box. Either head may be stopped without stopping the motor by means of a friction clutch, the operating handle of which when moved to disengage the drive simultaneously applies a brake for the purpose of arresting the ram in any desired position. From each back shaft power is transmitted to the associated headstock through a helical pinion and wheel to a swinging slotted link, which is connected by a pin and rod to a pin adjustable in a slot in the side of the ram. This, the Whitworth, type of driving movement is favoured by the makers in place of the central thrust form on the ground, among others, that it gives a uniform ratio of quick return to cutting speed of $2\frac{1}{2}$ to 1 on all lengths of stroke, as against a ratio for the other type of about 3 to 2 on the longest strokes and 1 to 1 on very short strokes. The Whitworth type is also preferred because it gives a slow speed at the beginning and end of the cutting stroke, which fact it is held prolongs the life of the tool and conduces to accurate work. The length of stroke is adjusted in the usual way by varying the position of the pin in the slot of the swinging link; the position of the stroke is varied by adjusting the pin in the slot at the side of the ram. Horizontal power feed to the headstock is obtained from a slotted crank and ratchet gear C, operated from the helical wheel of the main drive. Vertical feed to the tool box at the end of the ram is derived from a rocking quadrant D, mounted on the side of the ram and operating ratchet gearing, and thence, through mitre wheels, the vertical screw of the tool slide. This system of applying the vertical feed is claimed to be self-adjusting to suit varying lengths of stroke, and to be capable of instant release when the feed is not required. The tool box is arranged to be swivelled, and is provided with a quadrant and hand worm for executing curvilinear work. At E a mandrel can be attached to the bed for carrying circular work. When in use

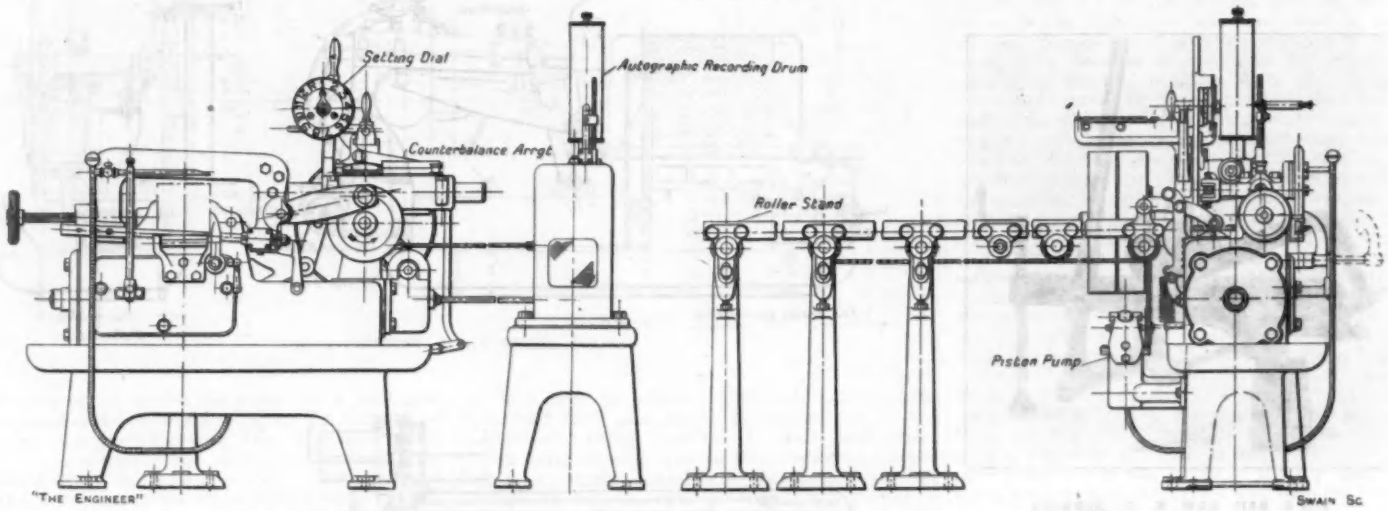


FIG. 9—6-INCH SAWING MACHINE WITH AUTOGRAPHIC BLADE-TESTING ATTACHMENT—E. G. HERBERT

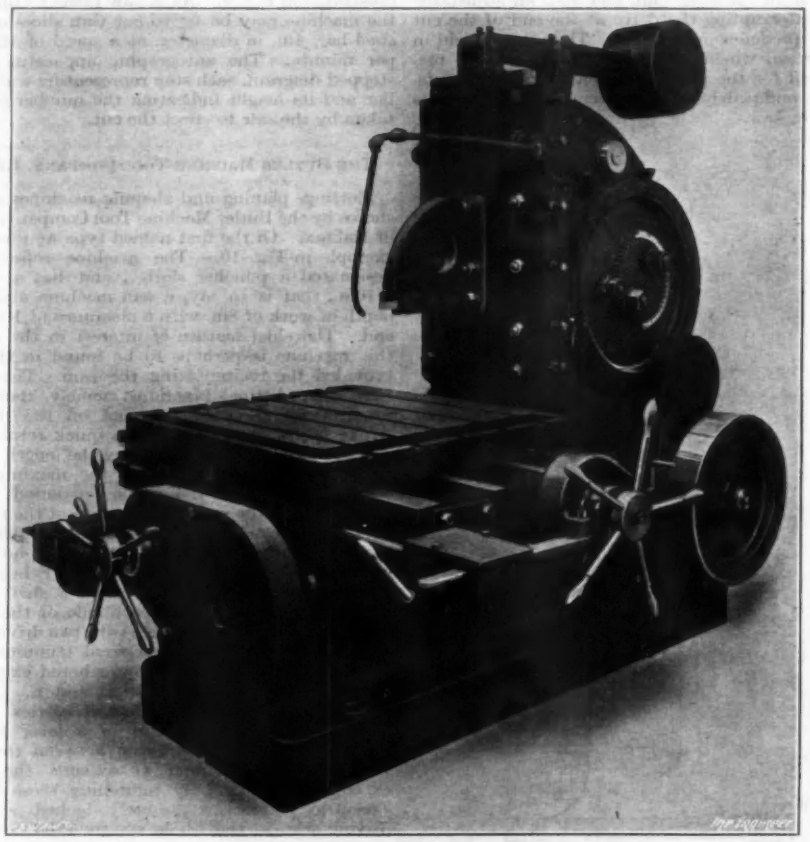

FIG. 10—PUNCHER TYPE SLOTTING MACHINE—BUTLER

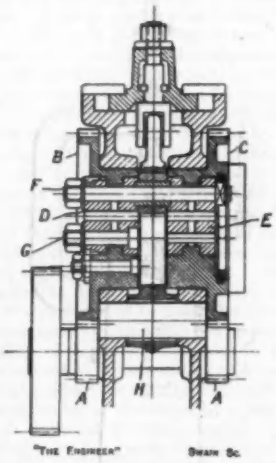


FIG. 11—RAM DRIVE OF SLOTTING MACHINE

# MACHINE TOOLS AT THE OLYMPIA EXHIBITION

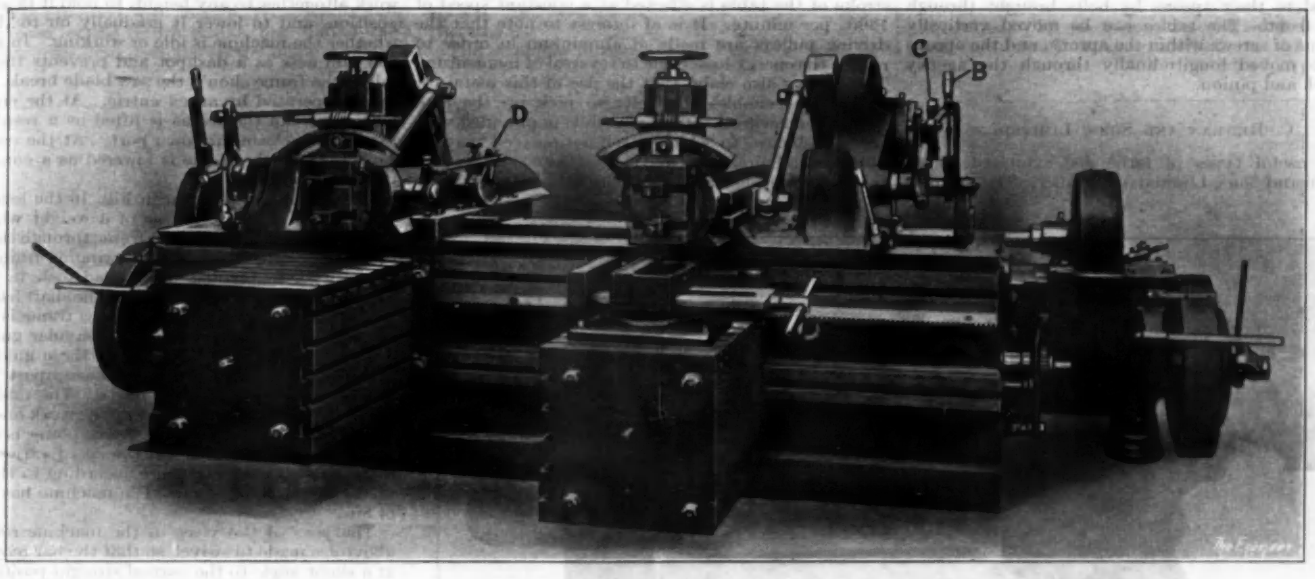


FIG. 12—DOUBLE TRAVERSING HEAD SHAPING MACHINE—BUTLER

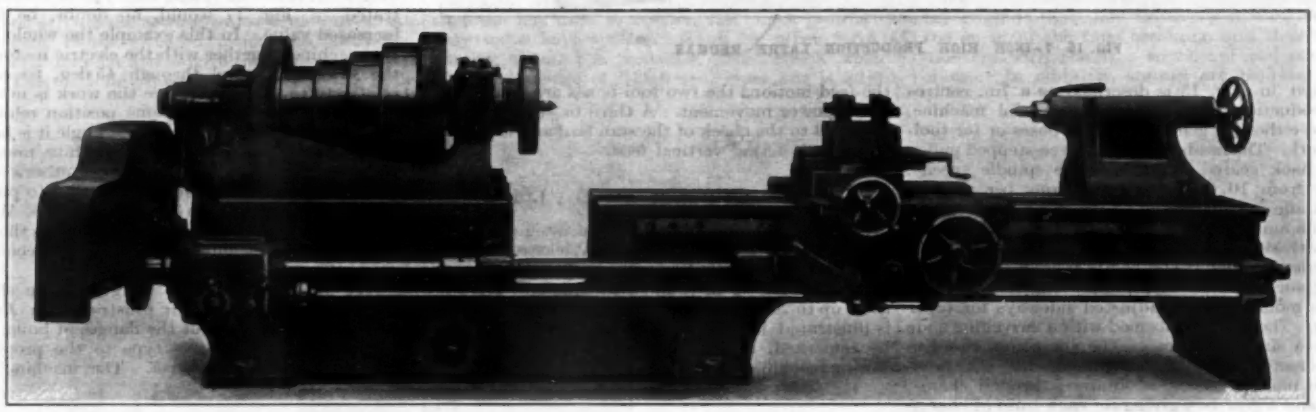

FIG. 13—13-INCH GENERAL PURPOSE LATHE—REDMAN

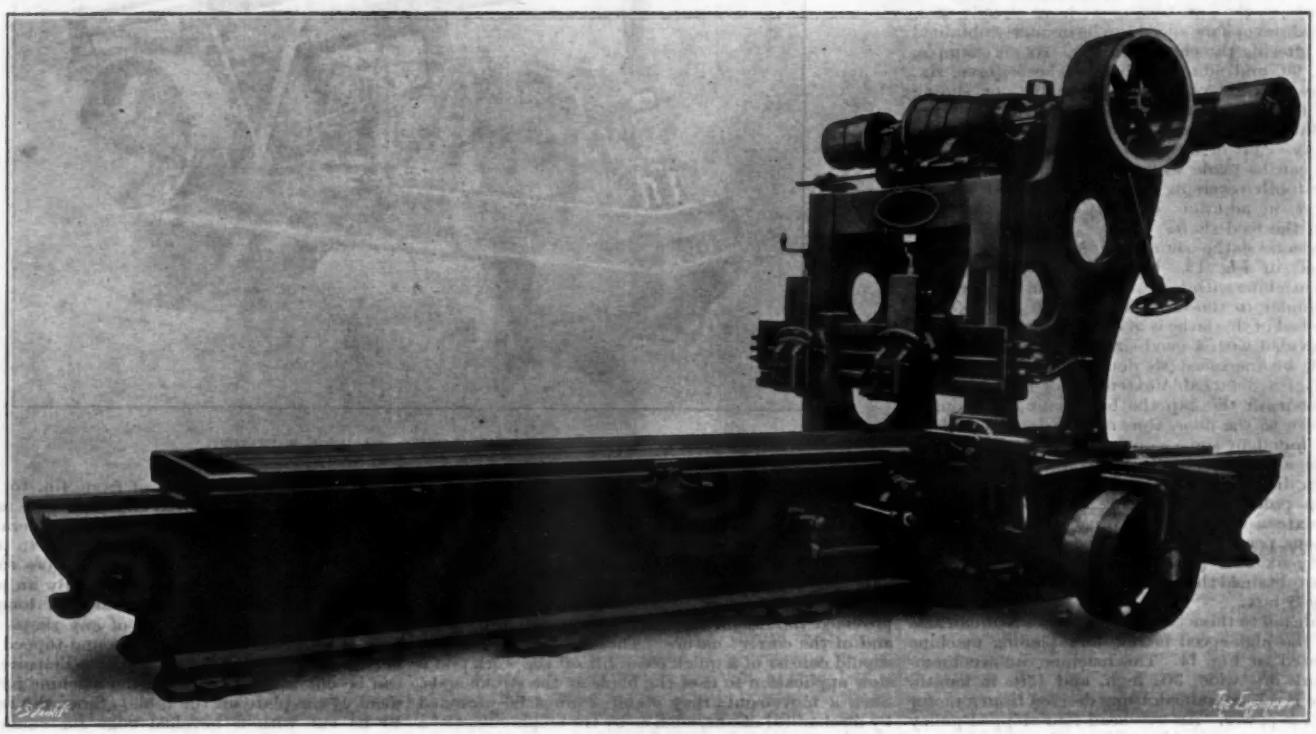

FIG. 14—HIGH SPEED PLANING MACHINE—REDMAN

this mandrel is stayed to the top of the adjacent work table, and is rotated by a self-acting feed operated from ratchet gearing F at the end of the bed. The work tables are of box form and are attached to their aprons by bolts brought through to the front. The tables can be moved vertically by means of screws within the aprons, and the aprons may be moved longitudinally through the agency of a rack and pinion.

### C. Redman and Sons, Limited.

Two useful types of lathe are exhibited by C. Redman and Sons, Limited, of Halifax. The example

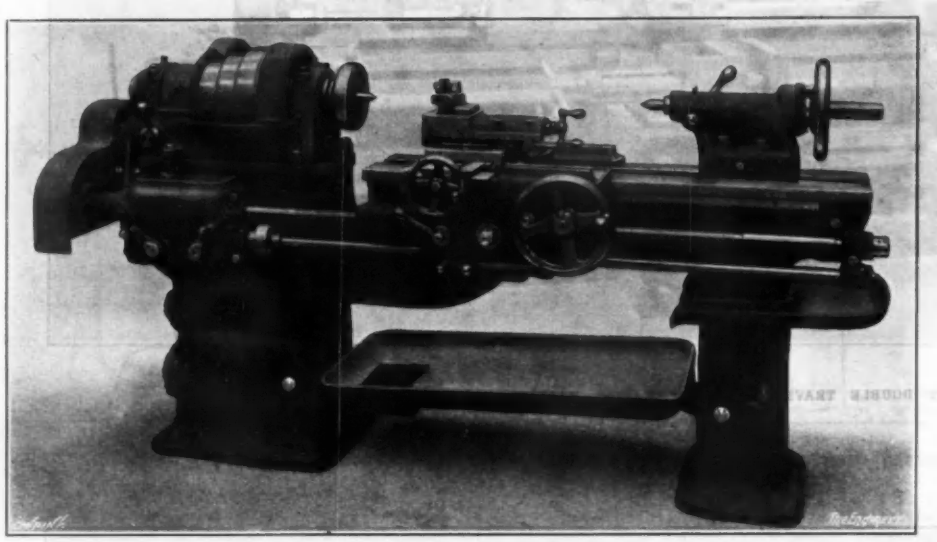

FIG. 15—7-INCH HIGH PRODUCTION LATHE—REDMAN

illustrated in Fig. 15 is described as a 7in. centres high production lathe. It is a powerful machine, designed either for general shop purposes or for tool-room work. The headstock has a three-stepped pulley and is back geared to give twelve spindle speeds, ranging from 10.4 to 420 revolutions per minute. The spindle is hollow and is made of high tensile steel, the surface being finished by grinding. It is fitted with self-oiling gun-metal bearings and with a ball thrust bearing. The bed is provided with wide bearing surfaces and deep square edges. The tail-stock is mounted to be adjusted sideways for taper turning. The saddle is formed with a swivelling slide rest for a similar purpose. The compound rest has a micrometer indexing attachment for the cross traverse motion. Feed is obtained through change wheels and a gear-box giving for each train of change wheels a fast, medium and slow speed. A second handle on the gear-box is used to transmit the feed either to the leading screw or the spline shaft. At the saddle the spline shaft motion is transmitted for the sliding or the surfacing feed according as a knob is pulled outwards or pushed in. It will be gathered that it is quite impossible to engage any two of the three feeds simultaneously. By means of the first handle on the gear-box, as we have already said, a fast, medium or slow speed can be instantly obtained without altering the change wheels. As an example, with 40, 90, and 60-tooth change wheels three, six, or twelve threads per inch can be cut, or sliding feeds of twelve, twenty-four, or forty-eight cuts per inch obtained, or, again, surfacing feeds of twenty-four, forty-eight, or ninety-six cuts per inch. These changes can be made while the machine is running. A single-tooth reversing clutch is provided for the feeds and, in addition, a safety slipping clutch is fitted on the feed shaft.

The second lathe shown by Messrs. Redman is illustrated in Fig. 13. It is a 13in. centres general purpose machine with feed and screw-cutting arrangements similar to those of the machine just referred to. The bed of this lathe is of some particular interest. It is provided with a good-sized gap, which may, as required, be increased to double its width by the removal of a detachable extension of the ways and rack. Beneath the gap the bed casting is brought right down to the floor, thus eliminating the lack of rigidity found in some gap bed lathes. The head-stock has a hollow spindle, which will admit bars up to 4in. in diameter. The spindle is driven through a four-step pulley, back gearing and change wheels giving sixteen speeds which range from 6.5 to 440 revolutions per minute. The feeds range from four to ninety-six cuts per inch and, as in the smaller lathe, are obtained through change wheels and a three-speed gear-box.

In addition to these two lathes Messrs. Redman also exhibit the high-speed heavy duty planing machine represented in Fig. 14. This machine can accommodate work 3ft. wide, 3ft. high, and 13ft. in length. Its drive is self-contained, being derived from a motor of 12 horse-power. An overhead four-stepped pulley gives four cutting speeds to the table, ranging from 30ft. to 63ft. per minute. These speeds can be instantly obtained while the machine is running, the endless belt on the overhead pulley being moved from step to step by means of gear operated from a hand wheel at the side of one of the standards. The return stroke of the table is effected at a constant speed of 120ft. per minute. It is of interest to note that the driving pulleys are made of aluminium in order to reduce the energy losses due to reversal of momentum. The makers also claim that the use of this metal for the pulleys enables the belts to pick up the load quickly on reversal. The cross slide is provided with two tool-boxes, to which a self-acting feed may be applied in all directions, and is itself raised and lowered by power through a friction clutch. In addition to the feed motions the two tool-boxes are fitted with a quick power movement. A third or side tool-box is attached to the cheek of the standard and is arranged with a self-acting vertical feed.

### Charles Wicksteed and Co., Limited.

Sawing machines of a variety of designs are to be found on the stand of Charles Wicksteed and Co. (1920), Limited, of Kettering. A large example, capable of taking in rounds, squares and other sections up to 20in. in diameter or the equivalent thereof, is illustrated in Fig. 16. Messrs. Wicksteed, it may be remarked, are firm advocates of straight-blade sawing machines, as against circular saws, particularly for heavy work, on the score of lower first cost, and speed, cheapness and efficiency of operation. Their machines are designed in accordance with the result, found in practice, that a straight blade working at a high speed will bear a load on the cutting stroke of 7 lb. per tooth. This high degree of loading, they claim, can be safely imposed on a modern blade, provided the lift on the return stroke is trustworthy and of the correct nature. That nature, they argue, should consist of a quick clean lift off the work and a slow application to it of the blade at the stroke ends. Such a movement, they claim, cannot be obtained by mechanical means, such as by the employment of a clutch. In all their machines it is secured by means of an oil ram. In the larger machines, including that illustrated in Fig. 16, the oil ram, besides lifting the frame on the idle—the outward or pushing—stroke, can be set to fulfil three other functions alternatively, namely, to lift the saw blade off the work altogether to any height, to hold it in any given position, and to lower it gradually on to the work, whether the machine is idle or working. In addition, the ram acts as a dashpot and prevents the sudden fall of the frame shou'd the saw blade break. The oil ram is operated by an excentric. At the end of the cutting stroke the frame is lifted as a result of the ram piston closing its own port. At the end of the return stroke the frame is lowered as a consequence of the expulsion of oil.

In the machine shown in Fig. 16 the load on the blade is adjusted by means of a weight which may be moved along the swinging frame through the agency of a coarse pitch screw. The swinging frame, it will be noticed, is pivoted on a headstock in bearings which are entirely independent of the shaft from which the reciprocating motion of the saw frame is derived. The saw frame is carried on two circular guides projecting from the swinging frame, these guides being disposed at a considerable distance apart in order to ensure steadiness to the frame. The table is provided with two vices, which grip the work one on each side of the blade. About two horse-power is absorbed in driving the machine, and the speed varies from 40 to 80 revolutions per minute according to the nature of the metal being sawn. The machine has a stroke of 8in.

The jaws of the vices in the machine referred to above are made to swivel, so that the bar may be held at a slight angle to the normal straight position. For angles of considerable magnitude the vices can be removed and the work bolted directly to the bed, which for that purpose is provided with a tee slot. Such a method of cutting work at an angle is no doubt all that is required if angle cutting has only occasionally to be done. If, however, it is a regular operation, and particularly if the angle of the cut is variable over a considerable range, the type of machine illustrated in Fig. 17 would, no doubt, be found of increased value. In this example the whole frame of the machine, together with the electric motor driving the saw, can swivel through 45 deg. to each side relatively to the bed. Since the work is not moved, but always occupies the same position relatively to the shop floor, no matter at what angle it is being cut, it is obvious that this type of machine must save a considerable amount of space that otherwise would have to be left unencumbered in order to permit the work to be angled. In addition, Messrs. Wicksteed claim, the labour involved in setting up the work is reduced. The machine illustrated will accommodate work measuring up to 20in. by 12in.

Yet another form of sawing machine shown by Messrs. Wicksteed is that illustrated in Fig. 18, a machine designed to cut the flanges of boiler fire-box plates of the locomotive type to the proper depth and at the requisite bevel. The machine cuts all

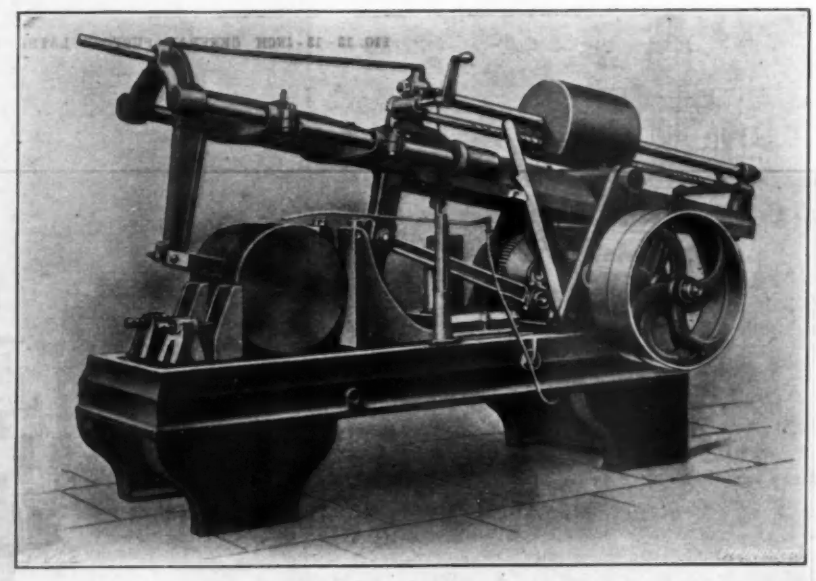

FIG. 16—20-INCH SAWING MACHINE—WICKSTEED

round the flange at a rate of from 4in. to 8in. per minute. The plate is placed on the circular table, but is not bolted thereto, for its weight is generally sufficient to resist the cutting force applied to it by the blade. Starting at one end, the saw goes round the whole flange without being re-set. By an alternate or combined use of the circular and longitudinal traverses of the table a plate of any shape—that is to say, between the limits of a round-topped fire-box or the more or less square-topped Belpaire form—can be cut without stopping the machine for adjustment of the plate on the table. Since the flange has to be cut with a bevelled edge for caulking and as consequently the blade has to be set at an inclination to the horizontal, it is essential that the distance

from the flange to the saw frame should be kept constant. This result is achieved by means of a roller which is attached to the cross slide carrying the sawing head and which is held constantly pressed up against the flange by an attached weight. The sawing head is provided with Messrs. Wicksteed's automatic release for the return stroke, but unlike those of the machines described above, the blade is pressed up to its work by a spring instead of by a weight, for the direction in which the pressure is required is horizontal and not vertical. The sawing head is mounted on a bracket which can be adjusted on vertical slides to give the required height of flange. On this bracket the motor driving the sawing frame is mounted. An independent motor situated inside the main bed operates the circular and longitudinal traverses of the table. The machine illustrated has a circular table

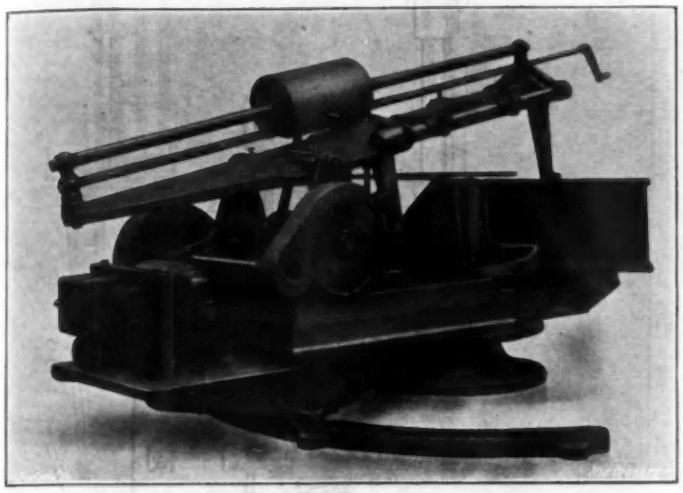

FIG. 17—SWIVEL HEAD SAWING MACHINE—WICKSTEED

table type, of which Messrs. Webster and Bennett were the originators, and for which they claim that it can show on almost all classes of work a bigger production than any other form of boring mill. As the duplex machine is already well known we have chosen for description two of the less familiar patterns.

The example illustrated in Figs. 19 and 21 is a single table machine with two ram heads, and permits of work having an exceptional length relatively to its diameter to be machined by two tools simultaneously. The table or chuck has four independent reversible jaws. It is worthy of note that the key used to operate the chuck jaws is the only loose key, spanner, crank or other form of handle about the machine. The chuck spindle runs in bearings of which the upper one is adjustable. Immediately under the chuck is a pressure ring of large diameter, continuously fed with oil, which takes the downward thrust and weight. Twelve speeds in geometrical progression are communicated to the chuck through a gear box, the handles for which are brought in a group to the front of the machine on the right-hand side. The speed changes are interlocked, and, in addition, the gears cannot be changed until the main drive has been interrupted. The interruption is effected by means of a friction clutch on the first motion shaft, which is controlled by a handle on each side of the chuck pedestal. The gear wheels in the change speed box are heat-treated nickel-chrome steel forgings. The lower row runs in oil, those above being splash lubricated. The tool rams are carried in swivelling and graduated heads attached to independent saddles on a cross slide, which moves vertically on guides formed on the machine standards. The rams are counterbalanced by compensating springs enclosed in cases carried at the top of the swivelling heads. Counterweights have been eliminated on the grounds that they involve a risk of accident in the event of the rope breaking, and that they may interfere with the free service of the machine by cranes. In addition, springs are held to facilitate

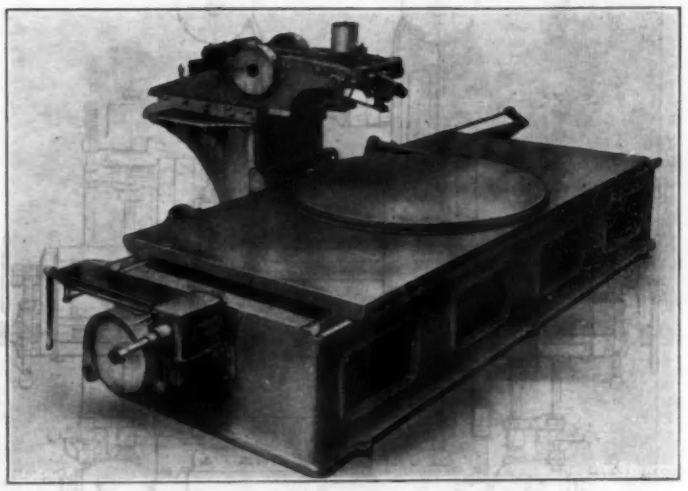

FIG. 18—FLANGE SAWING MACHINE—WICKSTEED

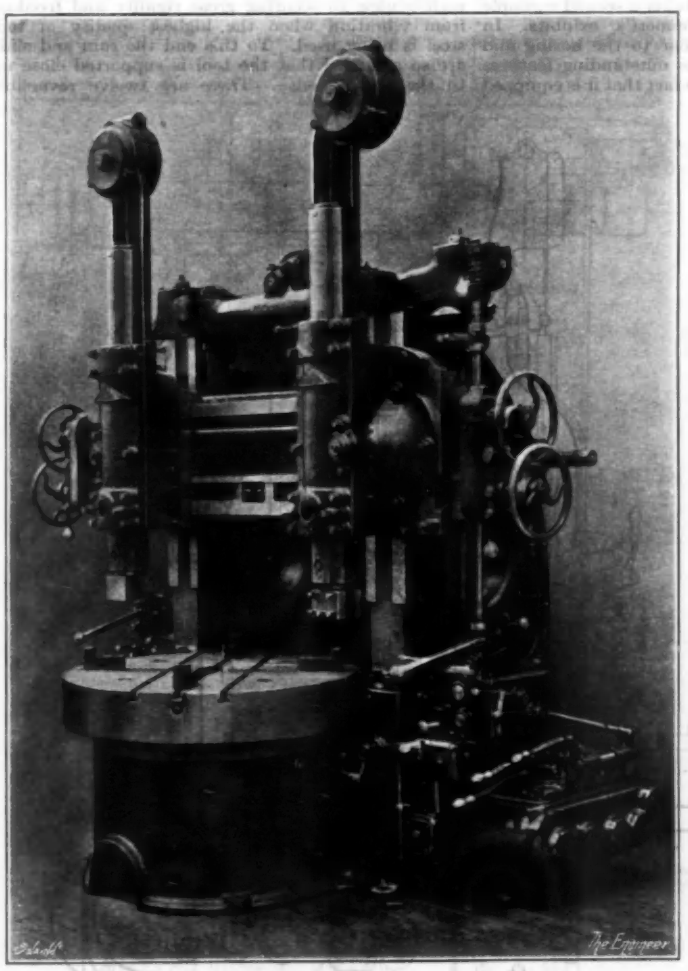

FIG. 19—SINGLE TABLE, TWO RAM BORING MILL—WEBSTER AND BENNETT

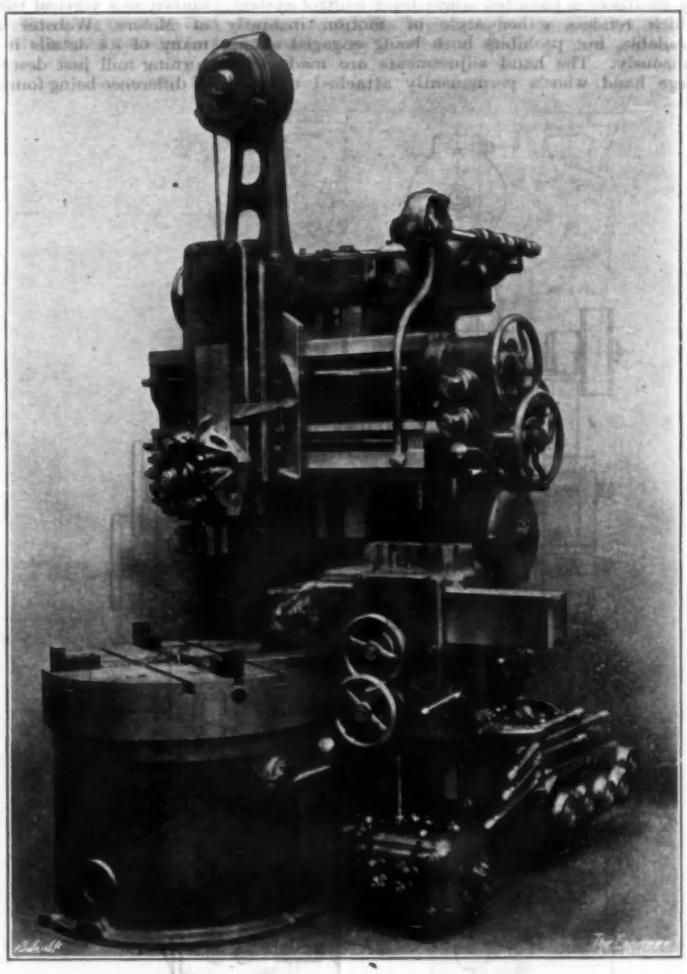

FIG. 20—VERTICAL TURRET LATHE—WEBSTER AND BENNETT

6ft. in diameter and will accommodate plates measuring up to 8ft. 4in. long by 5ft. 6in. wide.

### WEBSTER AND BENNETT, LIMITED.

Four different types of vertical boring and turning mills are being exhibited by Webster and Bennett, Limited, of Coventry. Three of these machines have single tables, while the fourth is of the duplex

the operation of the machine. The various movements provided in connection with the tool rams are as follows:—Twelve vertical or angular rates of feed for each ram relatively to its head; an equal number of horizontal feeds to each saddle relatively to the cross slide; rapid power traverses to the two saddles independently and to the cross slide; hand adjustments of the same nature. All the feeds are reversible, and are quite independent and separately

controlled for each head. They are selected by two handles at the front of the machine, on each side of the chuck. The feeds are interlocked among themselves, and a safety clutch is provided in the feed train to prevent damage being caused to the gearing by accident or carelessness. The rapid power traverse motion is interlocked with the feed motion by means of a patented single lever control system, which renders either style of motion instantly available, but prohibits both being engaged simultaneously. The hand adjustments are made from large hand wheels permanently attached to their shafts. Setting faces are formed on the ram saddles, in order that the rams may be set central relatively to the chuck, and adjustable micrometer collars are provided for setting the tools and sizing the work. The machine can admit work up to 45in. in diameter and 34½in. in height. The vertical feed of the rams covers a depth of 22in. The drive is obtained either from a belt pulley or from a 10 horse-power constant speed motor mounted, as shown in Fig. 21, on a platform attached high up on one of the standards and driving downwards by belt on to the first motion shaft.

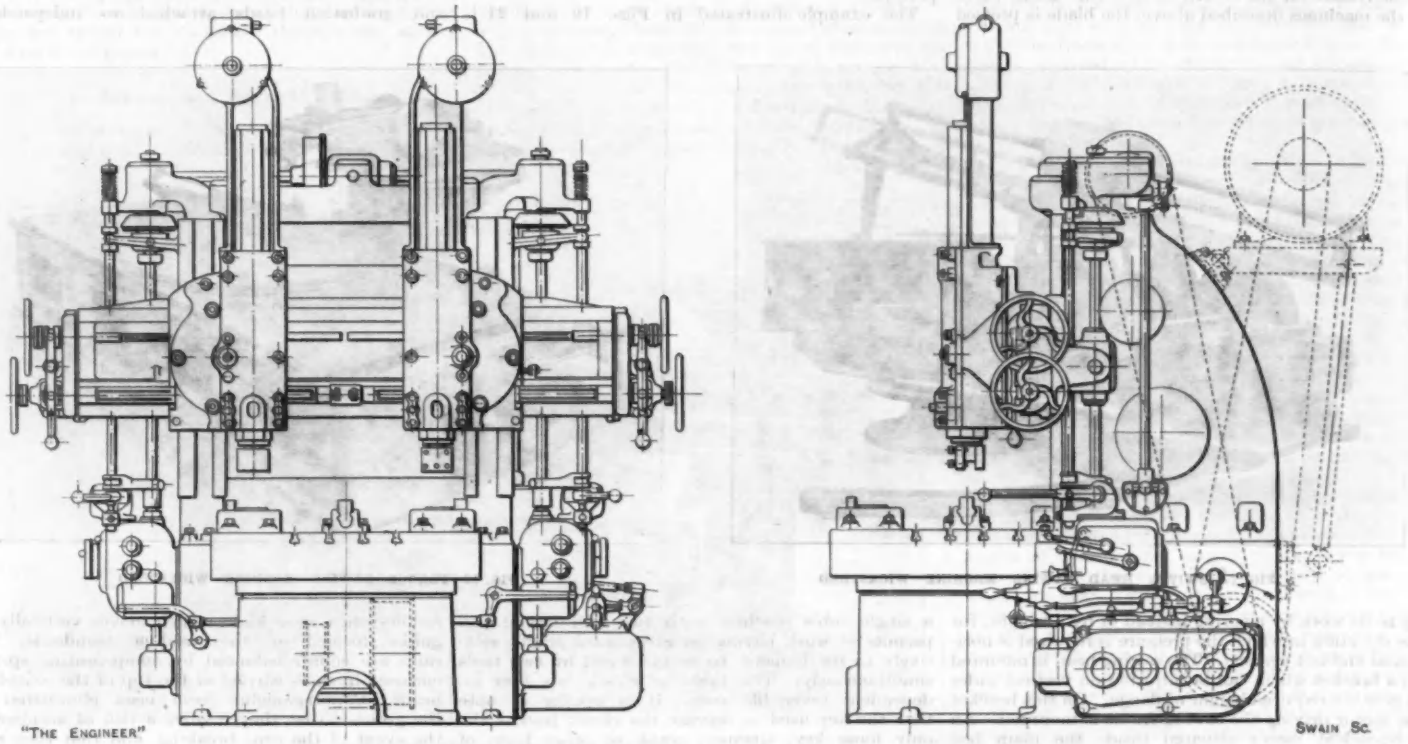


FIG. 21—SINGLE TABLE, TWO RAM VERTICAL BORING AND TURNING MILL—WEBSTER AND BENNETT

The machine illustrated in Figs. 20 and 22, known as a vertical turret lathe, is a second example of Messrs. Webster and Bennett's exhibits. In many of its details it is similar to the boring and turning mill just described, its outstanding features of difference being found in the fact that it is equipped with but one vertical ram, the place of the second being taken by a horizontal ram at the right-hand side of the chuck. The vertical ram carries a pentagonal turret, while the horizontal ram is furnished with a square turret. The vertical ram and the vertical slide carrying the horizontal ram, are balanced by springs in such a way that a constant pull is exerted throughout the travel of the ram or slide. The mounting and driving of the chuck are arranged on the same lines as in the previously described machine, twelve chuck speeds being obtained from a gear box at the right-hand side of the base. The horizontal ram and its slide have been designed with a view to securing great rigidity and freedom from vibration when the highest quality of tool steel is being used. To this end the ram and slide are so arranged that the tool is supported close up to the cutting edge. There are twelve reversible feeds to the main turret in the vertical, angular and horizontal directions, and a like number to the side turret vertically and horizontally. The two feed motions are entirely independent. On the main head patented feed trips actuated by dropping worms, which permit of very fine adjustments

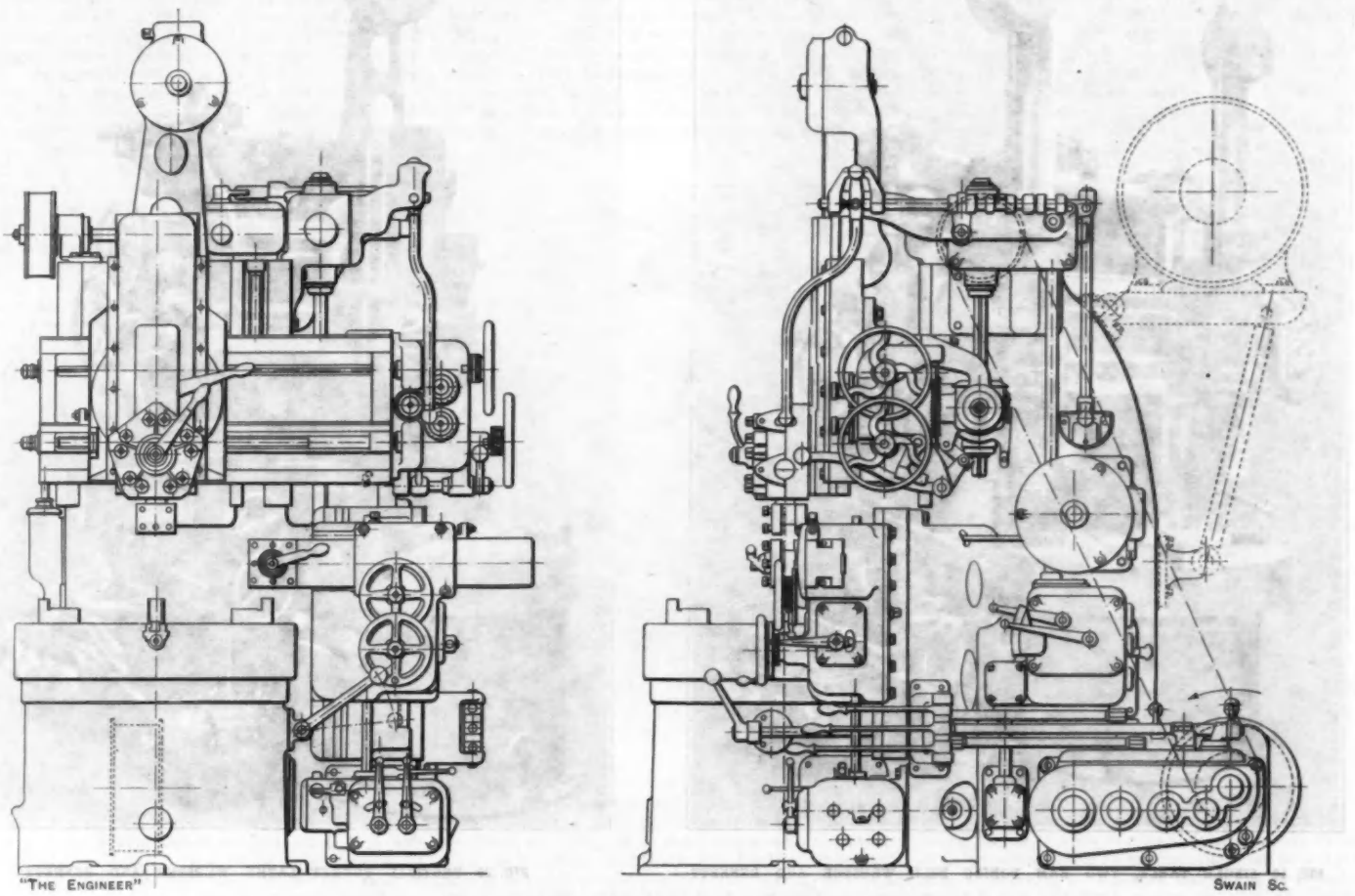


FIG. 22—SIDE HEAD VERTICAL TURRET LATHE—WEBSTER AND BENNETT

being made, are provided. Two graduated dials at the right-hand end of the main cross slide facilitate the setting of the feed stops and enable the progress of the tools over the work to be observed. Rapid power traverse in both directions can be applied to the main turret slides and hand adjustment is available for both turrets. The machine will admit diameters up to 38in. with respect to both heads. Under the main head a height of 35in. can be accommodated. This head has a vertical feed of 26in. and a horizontal feed from the centre of the chuck outwards of 21in. The side head has a total vertical movement of 20in., and its ram a horizontal movement of a like amount.

### JONES AND SHIPMAN, LIMITED.

On the stand of A. A. Jones and Shipman, Limited, of Leicester, the machine tools exhibited are principally drillers and grinders. In addition, the firm shows a large range of small tools and other details of machine shop equipment.

Among the grinding machines is the internal grinder illustrated in Figs. 23 and 25. This machine has been designed for the rapid production of parallel and taper holes from ¼in. diameter upwards, and also for the form grinding of ball bearing tracks. It can deal with holes up to 8in. diameter and 10in. in depth, and can swing 12in. over the table. The machine is driven from a slow-speed countershaft from which power is taken to the table-traversing gear and by crossed belt to a countershaft carrying a long pulley for the work head spindle drive. A separate high-speed countershaft is used to drive the grinding wheel spindle, and also a centrifugal pump, which draws water from a tank incorporated in the base of the machine and delivers it to the work being ground. As an alternative to the high-speed countershaft, the wheel spindle may be driven by a ¼ horse-power electric motor fixed to the cross slide carrying the spindle. The two countershafts, and therefore the work and the wheel spindles, can be started and stopped independently. In addition, the work head

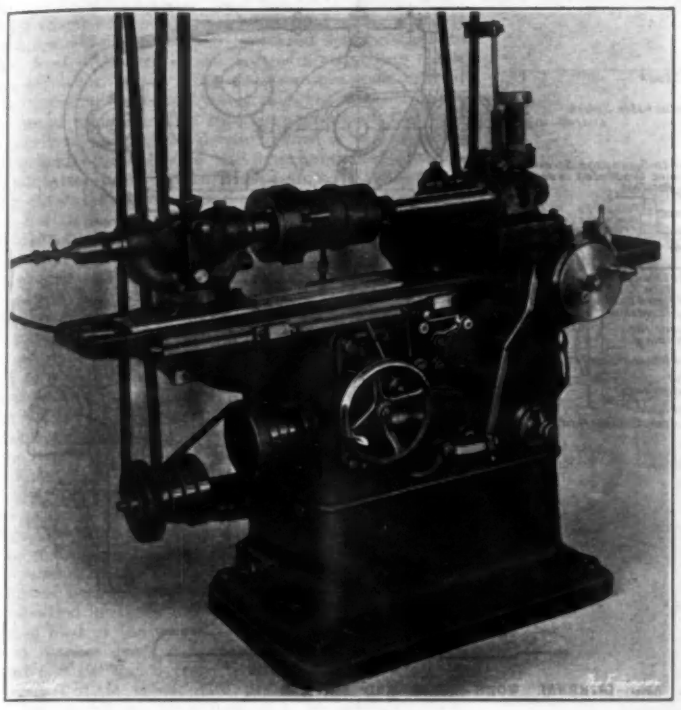

FIG. 23—INTERNAL GRINDING MACHINE—JONES AND SHIPMAN

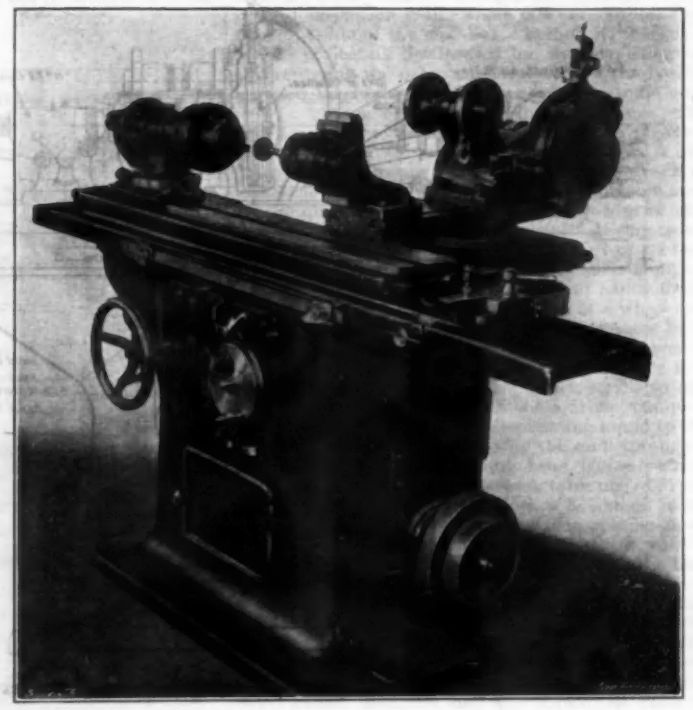

FIG. 24—UNIVERSAL GRINDING MACHINE—JONES AND SHIPMAN

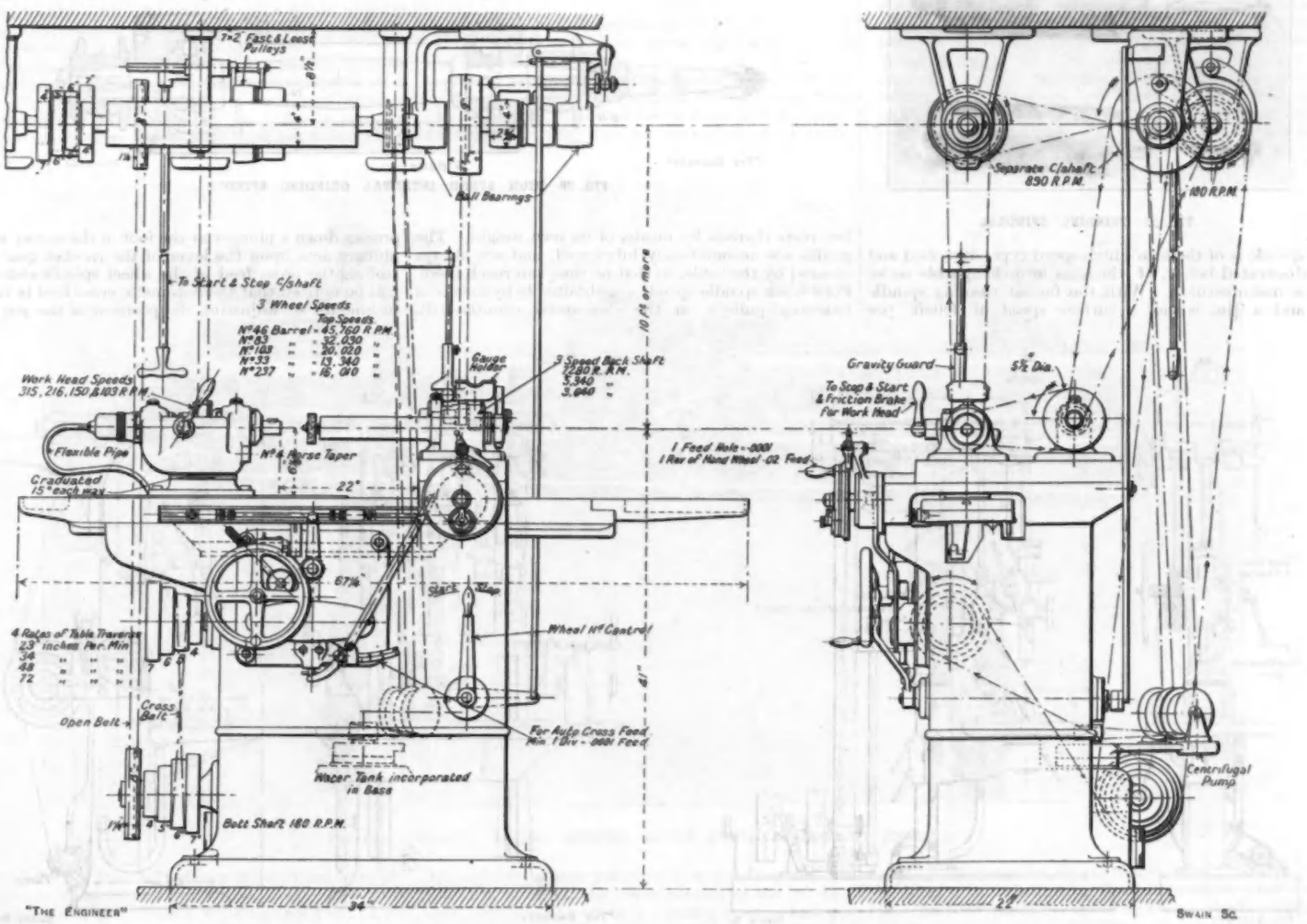


FIG. 25—INTERNAL GRINDING MACHINE—JONES AND SHIPMAN

spindle is provided with a clutch and a friction brake, whereby it may be instantly stopped or started. The grinding wheel spindle is carried on a slide, which is mounted to move crosswise on a bridge spanning the table motion. The work is carried in a chuck attached to the spindle of the work head. This spindle is hollow, and is carried in adjustable dust-proof bronze bearings, a double ball thrust bearing design of apron fitted to the front of the bed. This apron is removable as a unit for the purpose of inspection and repair, and contains all the mechanism controlling the travel and reverse motion of the table.

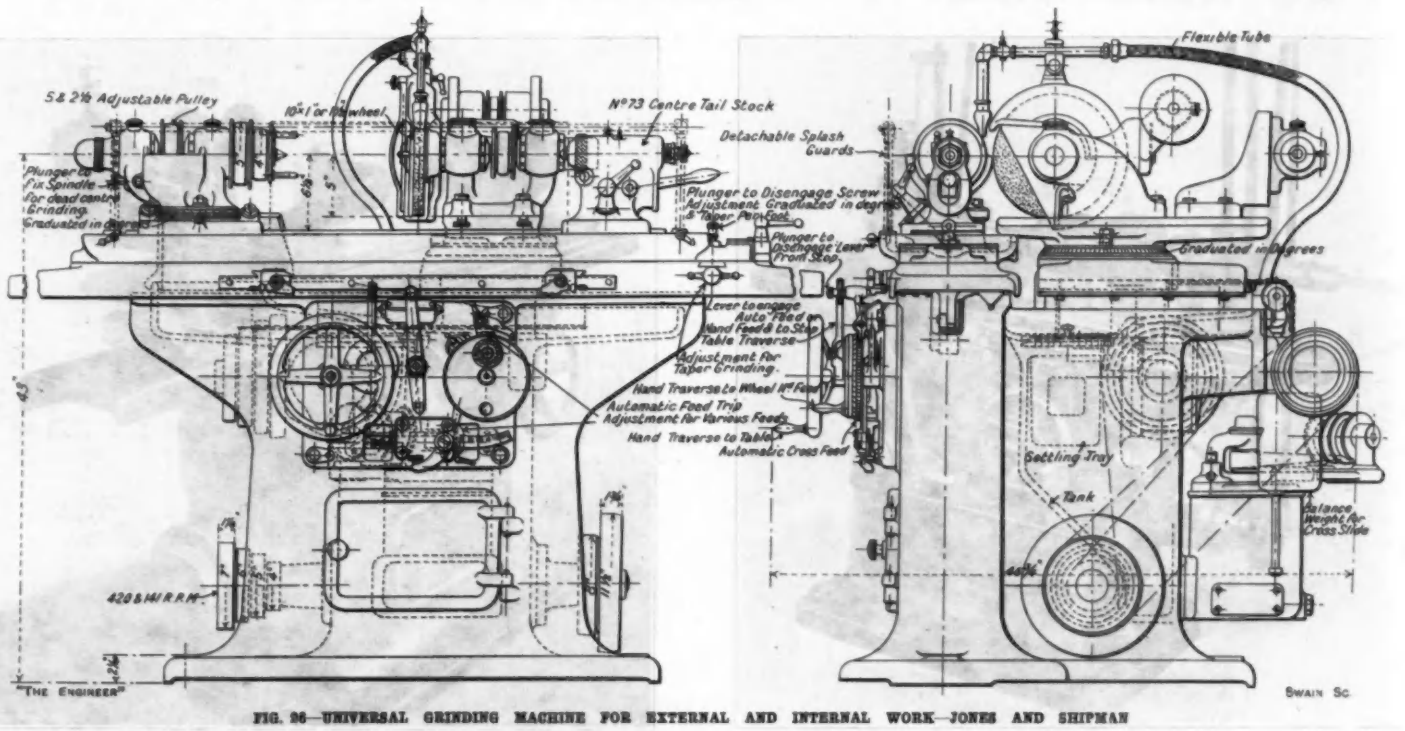
5 & 2½ Adjustable Pulley
10" I or Flywheel
No 73 Centre Tail Stock
Detachable Splash Guards
Flexible Tube
Plunger to Fix Spindle for dead centre Grinding. Graduated in Degs
Plunger to Disengage Screw Adjustment Graduated in degs & Taper Per Foot
Plunger to Disengage Lever From Stop
Graduated in degrees
Lever to engage Auto Feed & Hand Feed & to Stop Table Traverse
Adjustment For Taper Grinding.
Hand Traverse to Wheel Rest Feed
Automatic Feed Trip Adjustment for Various Feeds
Hand Traverse to Table
Automatic Cross Feed
Settling Tray
Tank
Balance Weight for Cross Slide
42 & 84 R.P.M.
"THE ENGINEER"
SWAIN Sc

FIG. 26—UNIVERSAL GRINDING MACHINE FOR EXTERNAL AND INTERNAL WORK—JONES AND SHIPMAN

the table. This cross slide carries a back shaft, with a three-stepped pulley, which is driven from the high-speed overhead countershaft, and from which power is transmitted by belt to the wheel spindle. The

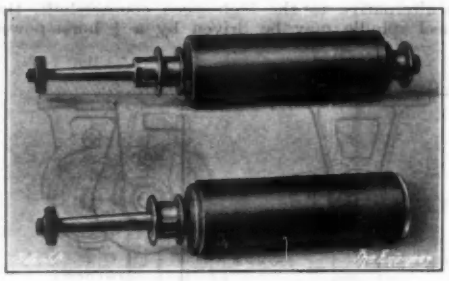

FIG. 27—GRINDING SPINDLES

spindle is of the firm's high-speed type, described and illustrated below, of which an interchangeable series is manufactured. With the fastest running spindle and a ¼in. wheel, a surface speed of 3000ft. per minute is obtained. Automatic cross-feed can be applied to the wheel spindle slide by means of ratchet gear operated from the apron. The feed rate can be varied from 0.0001in. to 0.0005in. per reversal of

being provided to take the endwise pressure. The head is mounted to swivel on its base, in order to permit taper holes to be ground. The base, in turn, can be adjusted on longitudinal tee-slots on the table top. The table is supported on one flat and one vee-guide on the bed. It is not held down on the guides,

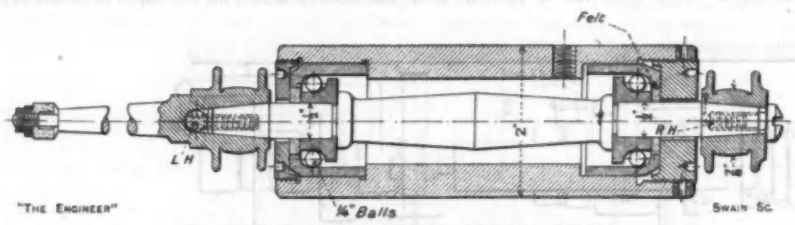


FIG. 28—HIGH SPEED INTERNAL GRINDING SPINDLE

but rests thereon by means of its own weight. The guides are automatically lubricated, and are always covered by the table, so that no dust can reach them. Four work spindle speeds are obtainable by means of four-step pulleys on the slow-speed countershaft. Four table traversing speeds, ranging from 23in. to 72in. per minute, are also provided, and can be used independently of the work spindle speed. The movement of the table is controlled by means of a standard

presses down a plunger at the foot of the apron, which plunger acts upon the lever of the ratchet gear controlling the cross feed of the wheel spindle slide. It will be noticed that the automatic cross feed is varied in amount by adjusting the position of the pin con-

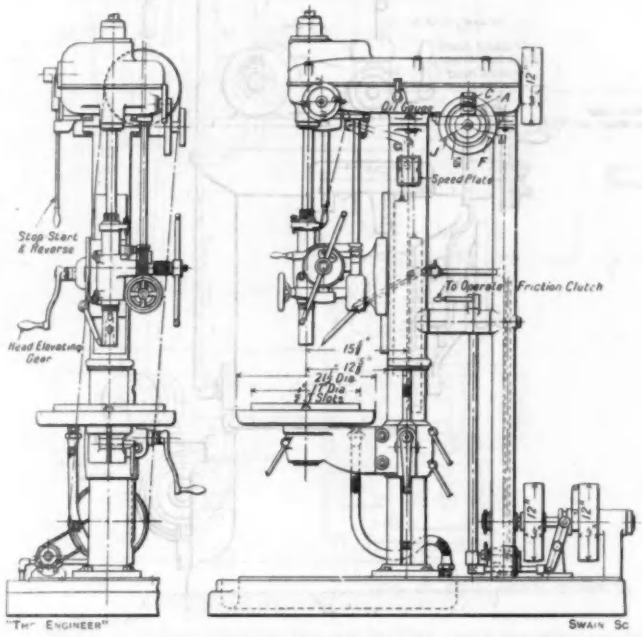


FIG. 29—HIGH SPEED DRILLING MACHINE—JONES AND SHIPMAN

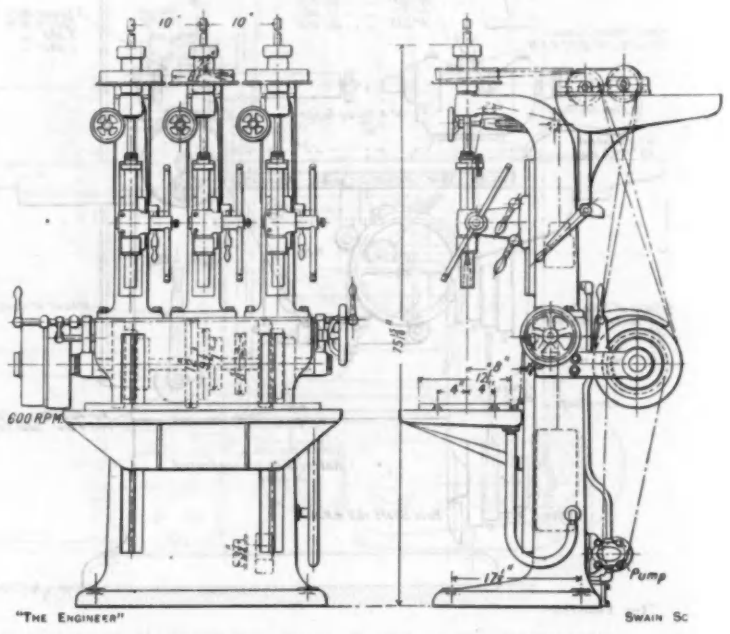


FIG. 30—SENSITIVE DRILLING MACHINE—JONES AND SHIPMAN

necting the lever to the link operating the ratchet mechanism.

Another example of the firm's grinding machines is illustrated in Figs. 24 and 26. This machine is

described as a universal grinder, because it is provided with a swivelling grinding head, which, when swung round, changes the machine from an external to an internal grinder. Apart from the removal of the tail-stock, this conversion is effected very quickly and simply by merely loosening two bolts and detaching and re-attaching the driving belt to the wheel head. The wheel head is carried on a cross slide, which is counter-weighted to give increased sensitiveness to the feed. The cross slide carries a swivelling table, to which are bolted in tee slots two brackets, one for the external grinding wheel and the other for the internal spindle. The internal spindle, of the type described below, is driven from a countershaft attached adjustably to the external wheel bracket. This latter bracket also carries an adjustable guard for the external wheel, and on top of this guard there is a clamp for fixing the water supply pipe. The work table slide is extended at both ends, so as to cover at all times the slide ways and protect them from grit and water. The work table is separate from its slide, being mounted thereon on a central spigot. It can be set over for taper grinding by means of a hand wheel and screw at the right-hand end, where it is also provided with a clamp and a scale graduated in terms of degrees and tapers per foot. The work head is fixed to the table on a swivelling base graduated in degrees. It carries the work either in a chuck or on a face plate, and can be fixed at any point along the length of its table. The tailstock is operated by a lever, and is provided with a spring arrangement, which may be adjusted for light or heavy work, and to prevent the centre from pressing into the work by more than a predetermined amount. In addition, the arrangement is such that it accommodates the expansion of the work, when it is being ground. The control gear for the work table feed and reverse is embodied in a box in the base of the machine. The cross feed to the wheel head is obtained by plunger and ratchet gear, as in the first-described machine, and can be varied from 0.0002in. to 0.0016in. per reversal of the table. An automatic trip is provided to knock off the cross feed at a pre-selected point. The machine can accommodate work up to 12in. in diameter and 24in. in length between centres. The wheel slide has a cross traverse of 6½in. and the work table a longitudinal traverse of 24in. The external grinding spindle has three speeds, namely, 1560, 2424 and 3860 revolutions per minute. The speed of the internal wheel depends upon which of the series of grinding spindles is in use. Eight speeds, ranging from 72 to 276 revolutions per minute, are provided for the work head spindle, and a similar number of speeds, ranging from 15in. to 109in. per minute, are provided for the work table traverse.

Two examples of the internal grinding spindles referred to in the above descriptions are illustrated in Fig. 27. The upper example, a section of which is shown in Fig. 28, is designed to run at a speed of 40,000 revolutions per minute, and has been tested up to 55,000. It is suitable for use in holes from ¼in. to ¾in. in diameter, and up to 2in. deep. The lower example in Fig. 27 has a working speed of 12,000 revolutions per minute, and is intended for holes up to 2in. in diameter and 2¾in. deep. Throughout the series a surface speed of 5000ft. per minute approximately is aimed at, for the firm strongly believes in the advantages of high speeds in grinding wheels. It is argued that with small wheels high speeds are necessary in order to prevent rapid wear and disintegration of the wheels. In the case of the spindle illustrated in Fig. 28, the ball bearings are of a special adjustable pattern, of the firm's own design. It is claimed that they can be run for long periods without requiring attention other than regular lubricating with best sperm oil. It will be noticed that this extra high-speed spindle is driven from both ends, the object being to balance the pull of the belt and to double the lap of the belt on the small size of pulley that must be employed.

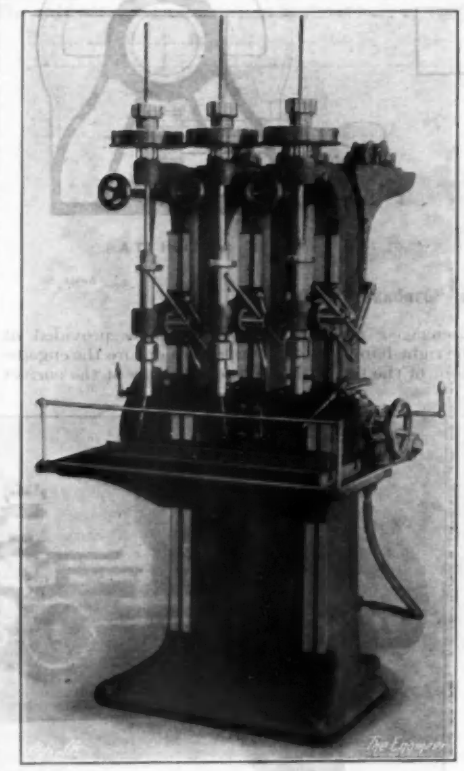

FIG. 21—SENSITIVE DRILL—JONES AND SHIPMAN

Among the numerous drilling machines exhibited by Messrs. Jones and Shipman the all-geared high-speed example, designed for drilling and tapping—illustrated in Fig. 29—is particularly noteworthy. The column of this machine, it will be noticed, is in the form of an H, the lower portion of the left-hand limb being machined to a circular section and provided with a rack for raising and lowering the work table, while the upper portion of the same limb is formed with sliding surfaces for guiding the drill head. The left-hand limb, it should also be remarked, is hollow, and contains two counterweights, one balancing the drill head and the other the drill spindle. Across the top of the column lies the gear-box, containing gear trains giving nine changes of spindle speed, ranging from 34 to 437 revolutions per minute, and other trains giving four rates of feed to the spindle, namely 53, 76, 124 and 179 revolutions per inch of advance. The spindle speed changes are obtained by means of two concentric dials, each having three stations, while the feed changes are controlled by a single four-station dial. These dials are situated on the front side of the gear-box. Behind it, there is a handle projecting downwards for starting, stopping and reversing the drive independently of the handle between the limbs of the frame, which handle controls a friction clutch in the driving pulley. The spindle, of forged high carbon steel ground to exact size, is rotated through bevel gearing, and is fed downwards by means of a quill, to which a rack of nickel-chrome steel is tongued. An adjustable stop on the quill can be set to interrupt the feed at any desired point by striking a projecting horizontal lever, which controls a dog clutch on the vertical feed shaft. In the drill head means are provided for engaging and disengaging the automatic and hands feeds. A fine hand feed is secured by means of a wheel and worm engaging with a worm wheel on a cross axle. An adjustable hand feed and quick return lever is also arranged on the head. Behind this lever is a knurled sleeve, a small turn of which serves to disengage or engage the feeds. A chain driven pump on the base of the machine supplies cooling liquid to the drill. The spindle can be fed by the quill through a distance of 12in. The sliding head has a vertical adjustment of 14½in., and the work table one of 21½in. With the work table in position, a height of 36½in. can be admitted between it and the spindle nose. With the table swung out of the way, 49½in. can be accommodated between the spindle nose and the base of the machine.

Another example of the firm's recent drilling machine practice is illustrated in Figs. 30 and 31, representing a very powerful type of sensitive drill. This design of machine is made with from one to four spindles. The drive from the line shaft is taken to a countershaft mounted half-way down the column. From a three-stepped pulley on the countershaft—one such pulley being provided for each spindle—a crossed belt is taken over a pair of idler pulleys to a two-stepped pulley on the spindle. The idlers are carried on a sliding bracket that can be raised or lowered by means of a cam operated by a lever projecting to the front of the column. In addition, the position of the idlers horizontally on their sliding bracket can be adjusted by means of a screw and hand wheel, which also project on the front side of the column, and by which the necessary tension can be given to the belt. The six changes of spindle speed thus obtainable are, the makers state, effected in from ten to twenty seconds. The spindle revolves in ball bearings within a steel feed sleeve, which is counterweighted, and which is fitted with a ball thrust bearing to take the pressure of the drill. The feed is applied by means of an adjustable lever. The work table is counterbalanced, the roller chain used for this purpose passing over a sprocket wheel, which, when operated by a hand wheel, provides a means of raising or lowering the table. The machine illustrated can drill rapidly and accurately holes up to 1¼in. in diameter and absorbs about 4 horse-power. The feed obtainable through the quill is 6in. The maximum dimension between the spindle nose and the table top in its lowest position is 32in.

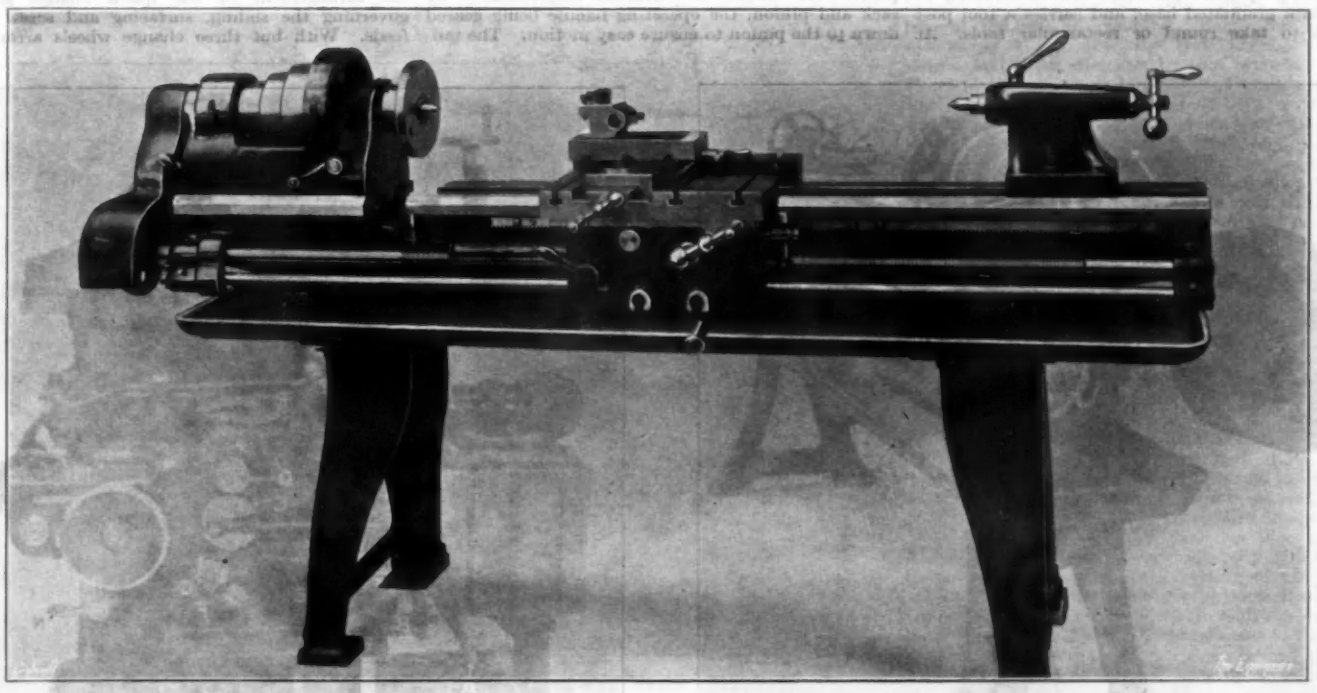

FIG. 22—"OSBORNE" 6½-INCH CENTRES LATHE—SELSON ENGINEERING COMPANY

### The Selson Engineering Company, Limited.

Among the machines on the stand of the Selson Engineering Company, Limited, of London, a considerable proportion are of overseas origin, but there are also several which have been made in this country, either at the firm's own works at Coventry or elsewhere. The British machines include the "Osborne" lathe, illustrated in Fig. 32, a simple machine no doubt, but one possessing interest by virtue of its being a direct attempt to meet the competition of the cheap German lathe. The design was produced with the object of testing whether that competition could be met without sacrificing good workmanship. Up to the present, the firm tells us, very satisfactory success has been achieved. The lathe has a centres height of 6½in., and is equipped for sliding, surfacing, and screw-cutting, all under power feed. No attempt, it will be noticed, has been made to cheapen production by employing the leading screw for the sliding and surfacing motions, the feeds for which, as is very desirable, being taken from a separate shaft. The bed is 6ft. 6in. in length, and is cast in one piece with the tray, a procedure which it is claimed gives a very rigid element and which eliminates distortion of the bed when it is bolted on to the legs. A gap is provided in front of the face plate, in which objects up to 20in. in diameter and 5in. in width may be swung. The bed viewed in section shows a slightly relieved flat guiding surface at the back and a double vee guide at the front. The saddle extends across the flat and the two vee guides. The tailstock base, on the other hand, embraces only the flat and the inner of the vee guides. The outer vee guide—it is of stouter section than the other—is thus preserved for the exclusive use of the saddle. Tee slots are formed in the saddle in order that with the slide rest removed work may be bolted to the saddle top for boring and other purposes. The slide rest is mounted to swivel on a graduated base, and carries a tool post designed to take round or rectangular tools. At the lower edge of the apron two notches are provided with which a sliding and lifting handle may be engaged, the left-hand position giving the surfacing feed connection and the right-hand the sliding feed. The screw-cutting feed is engaged by means of the lever to the left of the apron, which lever can only be operated when the dropping handle is in the disengaged position. An indicator is provided at the right-hand side of the apron to ensure the engagement of the nut with the leading screw at the correct point. The saddle is traversed longitudinally by rack and pinion, the operating handle being geared down to the pinion to ensure easy motion. The tailstock is divided and can be set over for taper turning. The headstock spindle is hollow and will admit a rough bar 1¼in. in diameter. Back gearing is provided—as shown in Fig. 33. The design is such that the gearing may be engaged or disengaged without the use of a spanner. The sleeve carrying the two lower wheels is mounted on an excentric shaft, which can be rotated through helical pinions from a cross shaft provided with a handle. The handle is held in the engaged or disengaged position by means of a ball and spring. The attachment of the fourth wheel of the back gear train to the front flange of the cone pulley is effected by means of a pin, which is held in the out or in position by means of a knurled nut. The change wheels are completely protected by a swinging cast iron cover, and are secured to the studs or shaft ends by multiple splines.

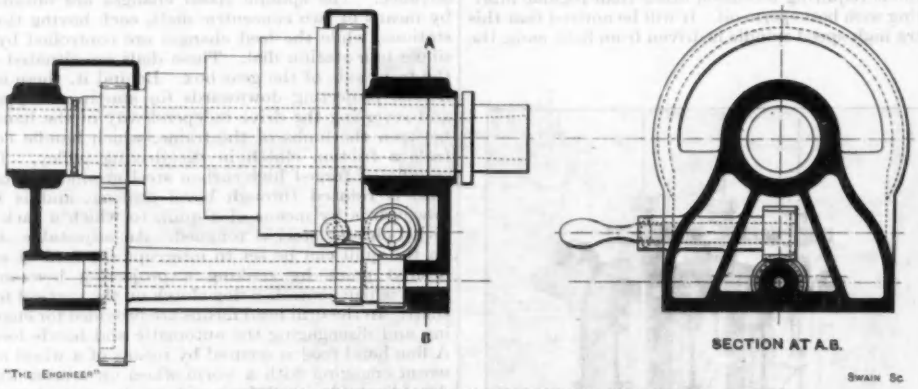


FIG. 33—BACK GEARING OF "OSBORNE" LATHE

A lathe of standardised design, produced at the firm's Coventry works on mass production lines, is also exhibited, and is illustrated in Figs. 34 and 35. The parts of this lathe, we are informed, are machined in economic quantities, and, after inspection, are put into store, whence they are drawn in smaller quantities for erection purposes. It has been found that greatest economy is achieved by erecting the lathes in batches of twelve, any larger quantity tending to produce congestion at certain stages, particularly in the final inspection of the completed machine. The lathe is described as a 13in. swing, vee-bed gap lathe. From the point of view of design the most noteworthy feature is perhaps the arrangement of the quick change gear-box governing the sliding, surfacing and screw-cutting feeds. With but three change wheels arranged in two orders—60, 90, 30 and 30, 90, 60—twenty-eight different pitches, ranging from 2 to 28 threads per inch can be cut, or alternatively sliding feeds from

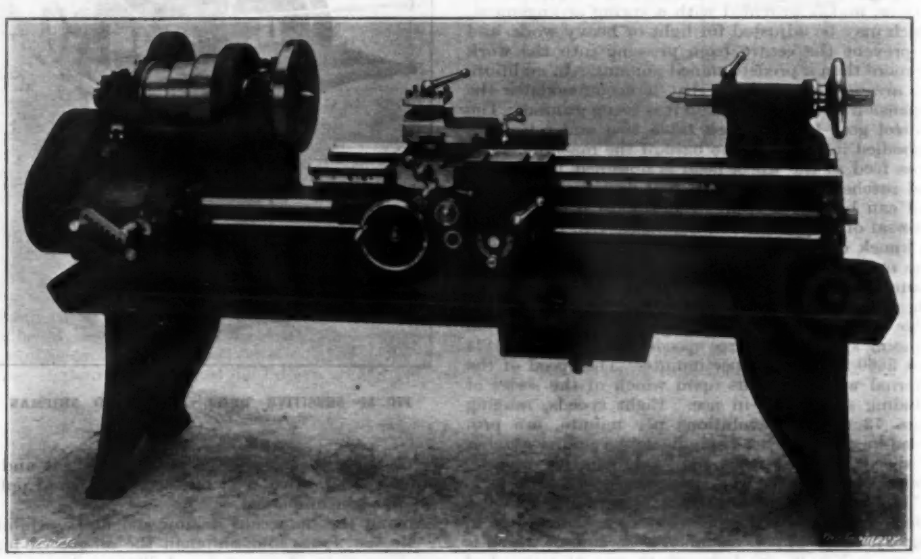

FIG. 34—13-INCH GAP LATHE—SELSON

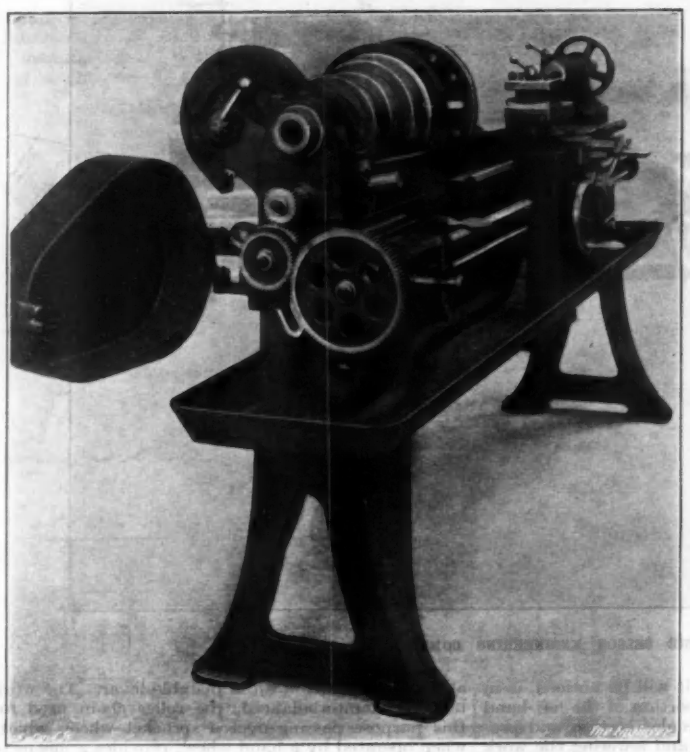

FIG. 35—13-INCH GAP LATHE—SELSON

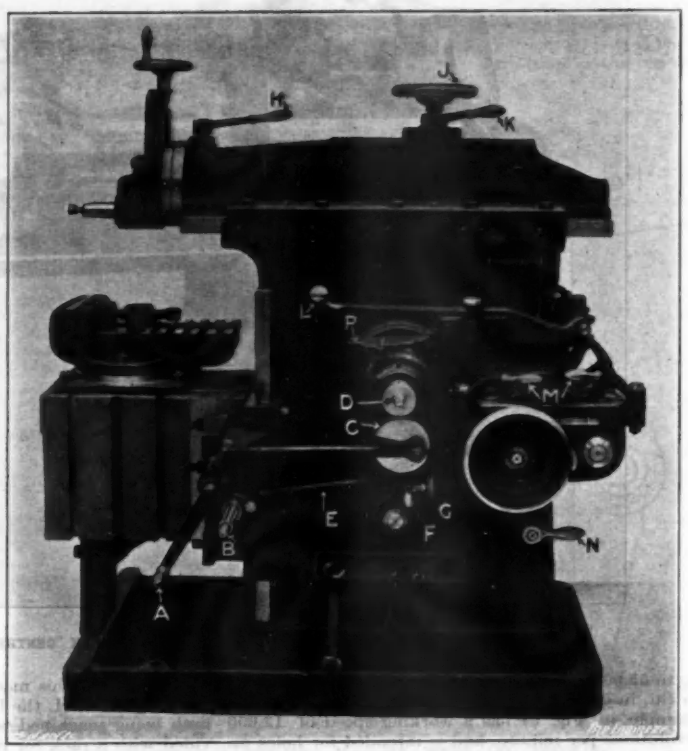


FIG. 36—17-INCH SHAPING MACHINE—SELSON

5 to 72 cuts per inch, or surfacing feeds of 10 to 144 cuts per inch, can be obtained. The gea -box gives seven changes by means of a tumbler handle engaging with one or other of a series of seven notches, the range being doubled by means of a crank handle controlling a two-speed gear and doubled again by altering the order of the change wheels. The gear-box forms a complete unit, and is bolted to a face on the front of the bed. It may be bodily removed, and in its place may be fitted, if desired, a three-speed gear-box of a simple sliding gear type, in which case the feed and screw-cutting ranges are completed by means of change wheels. Fig. 35 illustrates the lathe with the three-speed gear-box fitted. The headstock is back geared, and encloses reverse gearing, which is controlled by means of a lifting handle lying above the gear-box. The spindle is bored to admit 1½in. diameter bars, and the bed is formed with a gap and a detachable gap piece enabling short work up to 20in. in diameter to be swung. The apron is cast in one piece, and, in addition to the sliding and surfacing feed gearing, contains mechanism whereby these feeds may be reversed from a single handle at the front. The compound slide rest can be swivelled to any position, and carries a square turret for four tools of ¾in. square section.

A third lathe shown by the Selson Engineering Company is similar in many of its details to that just described, except that it is larger—it can swing 17in. over the bed as against 13in.—and is equipped with an all-gear drive to the headstock. The gearing gives eight different spindle speeds, and is controlled by a friction clutch which is put into or out of action by means of a wooden rod extending horizontally above and along the full length of the bed within easy reach of the operator. The spindle speed changes are effected through the agency of two handles on top of the headstock cover. These handles are the only attachments on the cover and, as a consequence, the cover can be readily removed for the adjustment or dismantling of the internal parts of the head. For simply inspecting the parts, holes are provided in the cover which obviate its removal.

The company also exhibits some high-speed heavy-cutting shaping machines of its own design and manufacture. In Fig. 36 we illustrate an example having a maximum stroke of 17in. The work is held in a heavy vice bolted to an open fronted table, which is supported on a foot provided with rollers which bear on a planed face on the pedestal base. The table is bolted to a tee-slotted apron, which slides horizontally on a saddle adjustable vertically on guides formed on the pedestal. The table may, if required by the form of the work to be operated upon, be unbolted from its apron, which is then left free for the direct attachment to it of the work. Hand adjustment of the table and apron is obtained by means of the handle A if horizontal movement is required. Vertical adjustment is secured by applying the handle to the shaft B. A ratchet feed in the horizontal direction is obtained from the slotted crank disc C, the pin in which may be adjusted against a graduated scale to vary the feed obtained. The bracket carrying the disc C can swing about the axis D, and is tied to the vertical slide by a compensating link E. In this way, as the table is raised or lowered, the bracket swings on its axis, and preserves the ratchet gear in proper engagement. At F a dropping handle is provided, whereby the rotation of the feed crank disc and the movement of all the other parts of the feed gear may be stopped while the machine is running, in order that the rate of feed may be varied if necessary. The handle F is normally held by a spring in the engaged position, but can be locked in either the engaged or disengaged station by means of a knob G. Thus after the feed has been stopped and adjusted it can be brought into action again simply by a slight turn of the knob G. The ram is equipped with a swivelling tool head that can be locked at any angle by means of the handle H. Hand feed is applied to the tool slide, but if desired a power feed can be arranged. The adjustment of the position of the ram is secured through the agency of a rack and pinion operated from the hand wheel J. When the required position has been attained the adjusting means are locked by the handle K, which is mounted on the screwed shaft of the adjusting hand wheel, and which operates by pressing a serrated block against serrated faces on the top of the ram. The machine is driven by a single belt pulley, from which the belt may be struck on to a loose pulley by the handle L, which, projecting to the front of the machine, can be operated by the attendant without his moving his position or taking his eye off the work. Power is transmitted from the belt pulley shaft to the ram through a gear-box providing four changes of speed by means of the handles M, which changes are doubled in number by means of single or double gear working controlled by the handle N. The reciprocation of the ram can be varied over a range from 2in. to the maximum of 17in., the adjustment being effected by means of a handle applied to the shaft D. Immediately above this shaft a quadrant P, against a scale on the face of which a pointer moves, permits the length of stroke of the ram to be adjusted to any desired amount, either while the machine is running or while it is stationary. It is worthy of note that the pointer does not oscillate when the machine is in motion. Indeed, the whole details of the stroke length adjusting gear are deserving of attention, for they clearly represent an advance on the trial and error method of adjustment previously used on some designs of shaping machine.

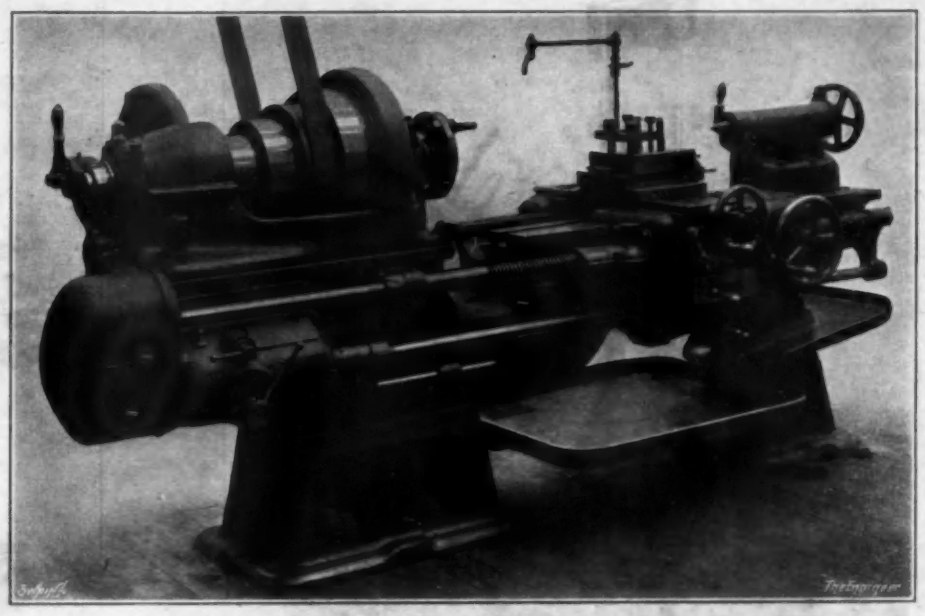

FIG. 36—BACK GEARED 8½-INCH LATHE—DEAN, SMITH AND GRACE

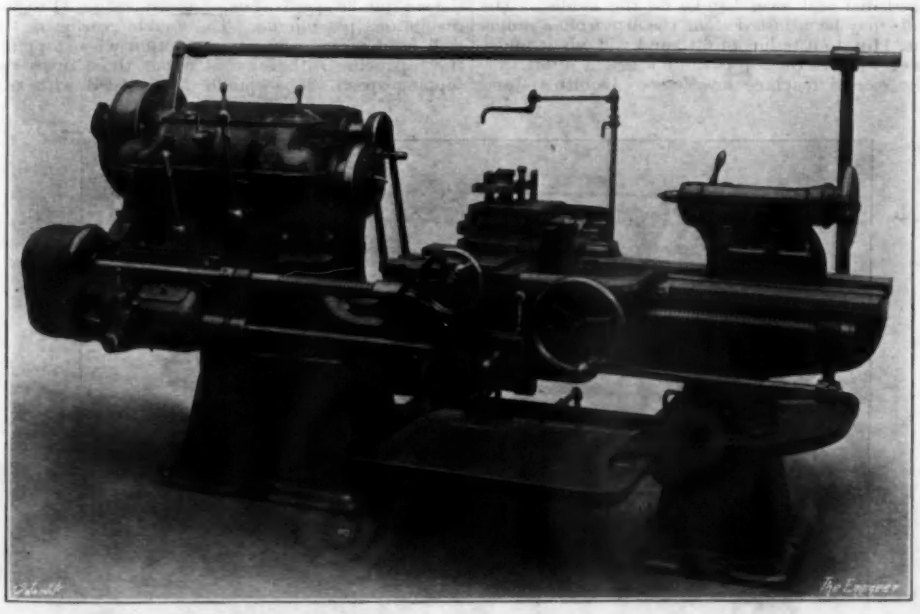

FIG. 37—ALL-GEARED 8½-INCH LATHE—DEAN, SMITH AND GRACE

### DEAN, SMITH AND GRACE, LIMITED.

An interesting exhibit of lathes is shown by Dean, Smith and Grace (1908), Limited, of Keighley, some of which are of the all-geared headstock type, while others obtain the change of spindle speed partly by belt cone and partly by gearing. An example of the all-geared type is illustrated in Fig. 37. This lathe has a centres height of 8½in., and on a bed measuring 8ft. overall will admit work 3ft. 7in. long between the centres, that is, 45 per cent. of the bed length. That the all-geared type of lathe is economical in this respect seems to be suggested by the fact that an 8½in. centres lathe with a four-step cone and geared drive, exhibited by the same makers, and having the same overall length of bed, admits only 3ft. 3½in. between the centres or just under 41½ per cent. of the bed length. The lathe referred to is shown in Fig. 38. The difference is perhaps small, but it is made more significant by the fact that whereas the all-geared lathe has sixteen spindle speeds, the other has but eight. Both lathes have several features in common. Each, for instance, can swing 17½in. over the bed, 12½in. over the saddle, and 30½in. diameter by 10in. wide in the gap. The bed in both cases is supported on two feet, of which that beneath the fast headstock provides accommodation for the change wheels, of which there are fourteen all told. The saddle is equipped with a compound rest having a swivelling adjustment for taper turning. Longitudinal movement is imparted to the saddle by means of a rack and pinion, a handle projecting through a slot in the apron being employed to convert the sliding movement into a surfacing one. It is impossible to engage both these feeds simultaneously, and an interlocking arrangement is provided to prevent either being engaged simultaneously with the screw cutting feed obtained from the leading screw. An adjustable stop is arranged to trip the sliding motion, and provision is made for stops to act in conjunction with the cross feed. The leading screw in both machines has a pitch of ¼in. and is guaranteed by the makers to have an aggregate accuracy of 0.006in. in a length of 6ft., and of 0.003in. in any foot of its length. A gear box attached to the front face of the bed at the fixed headstock end permits a feed of 48, 36, 24 or 12 cuts per inch to be applied to the sliding or surfacing motion. The gear-box also contains a set of screw-cutting gears, whereby four pitches may be obtained from each setting of the change wheels. A reversing movement for the feed and screw cutting motions of the saddle is, in addition, provided in the gear-box. The feed is transmitted to the saddle through a slip coupling, and it is claimed that the lathe may be worked up to the slipping point without damage being caused. In the all-geared lathe the fast headstock carries a single pulley 12in. in diameter, and running at 400 revolutions per minute. A friction clutch and brake are provided for starting and stopping the drive to the spindle. Sixteen spindle speeds ranging from 300 to 13.4 revolutions per minute can be obtained from the gear trains within the headstock. All the spindles in the headstock run in ball bearings, and the thrust is taken on a standard ball thrust bearing. A pump is fitted inside the head to supply all the wheels and bearings with lubricating oil. The lathe illustrated in Fig. 38, has back gearing with a ratio of 7 to 1,

which, with the four-step cone, gives eight spindle speeds ranging from 340 to 12.1 revolutions per minute. Both lathes have hollow spindles, the bore in the all-geared example being 2¼in. in diameter and in the other 2½in. The horse-power required to drive the lathes is about five. The all-geared form, as exhibited at Olympia, is driven from a 5 horse-power Metropolitan-Vickers motor carried on a swinging bracket attached to the foot beneath the fixed headstock.

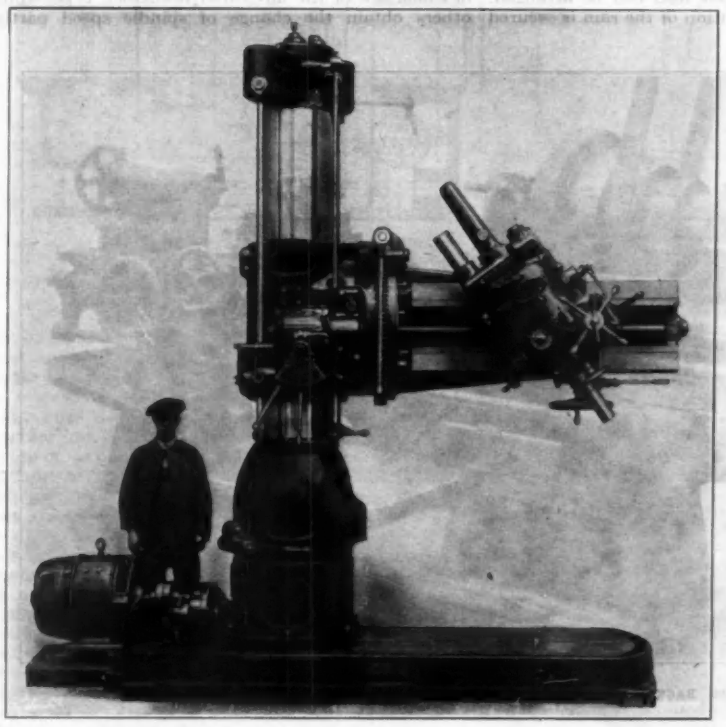

FIG. 39—UNIVERSAL RADIAL DRILLING MACHINE—ASQUITH

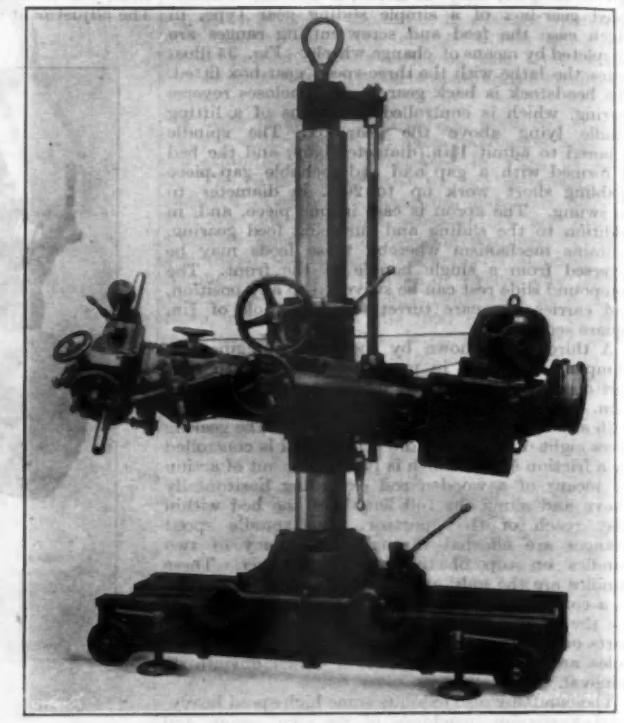

FIG. 40—PORTABLE RADIAL DRILLING MACHINE—ASQUITH

### William Asquith, Limited.

Drilling machines of a wide variety of design are exhibited by William Asquith (1920), Limited, of Halifax. The general features of this firm's machines are well known to our readers, but the two which we have selected for description are, we think, of particular interest, for they represent in different ways the high degree of development to which Messrs. Asquith have now brought their machines.

The universal radial drilling machine—shown in Fig. 39—contains many features typical of the firm's present-day practice, with, as a special feature, an arrangement whereby the radial arm may be swivelled through a total angle of 180 deg. by means of worm gearing and a ratchet motion. In addition, the saddle carrying the spindle can be swivelled through 85 deg. by means of a similar arrangement of parts. It is thus possible on this machine to present the drill to the work either vertically or horizontally from either side or inclined at any angle to the vertical and to the horizontal centre line of the base-plate. Both swivelling motions are provided with indexing details, with a secure lock and with a stop pin which determines the spindle in a vertical position. The provision of this double-swivelling movement would entail with an ordinary loose balance weight some possibility of trouble, when either the arm or the saddle or both were tilted. To overcome this difficulty, the counterweight for the spindle is not hung so that it may swing about, but is geared off the spindle itself. In another respect the introduction of the double swivelling motion has resulted in a departure from ordinary practice. The arrangement of the spindle drive to suit the swivelling motion has led to the disuse of a sleeve for supporting the spindle, but it is claimed that the alternative design adopted gives the necessary strength and rigidity for the duty for which the machine is intended. The machine is designed not only for drilling, but for boring, tapping and studding. It is driven by a 10 horse-power motor mounted on the base-plate. A gear box at the end of the radial arm, together with double gearing on the saddle, gives eighteen spindle speeds, ranging from 20 to 405 revolutions per minute. The machine is thus equipped to drill in steel holes from 7½in. diameter down to ¾in. When a hole is being drilled in an inclined position the spindle speed and also the rate of feed are reduced. In a modern machine tool, especially one such as this, having a wide range of movements, speeds and feeds, it is not sufficient to bring the controlling handles within easy reach of the operator. They must, in addition, be so arranged that any desired motion, speed or feed can be quickly and with certainty selected by the attendant. The machine we are now dealing with is worthy of study in this respect by reason of the simplicity of the means provided for selecting any one of the eighteen spindle speeds. The gear-box at the end of the radial arm is provided with two downwardly extending levers, each of which has three stations, one to the left, one central, and one to the right. Both levers may be set in the same station, giving three changes, either may be central, while the other is to the right or left, giving four changes, or one may be to the right while the other is to the left, giving two changes—or a total of nine changes. The double gearing on the saddle gives two spindle speeds for each setting of the gear-box handles. A sector above the handles clearly sets forth the two speeds obtainable with each setting, and, in addition, marks against each speed the size of drill for which that speed is suitable, both for steel and for cast iron. It is, of course, essential to distinguish between the two handles. The plan followed in this connection is not to letter them A and B, but to distinguish them by different shapes of knobs at their ends. The operator's sense of touch is thus brought to the assistance of his eyesight. The feeds, of which there are four, ranging from 35 to 120 cuts per inch, are obtained from an equally clearly marked dial and lever handle on the saddle. The spindle may be adjusted along the arm from a radius of 2ft. 1lin. to a radius of 6ft., and will admit under its nose when in the top position a height of 6ft.

The second machine on Messrs. Asquith's stand which we have chosen for description is the portable universal radial drilling and tapping machine, illustrated in Fig. 40. A machine of this class can fulfil an important function in engineering establishments of several kinds, for it is frequently difficult to take assembled or partly assembled work to a machine for drilling and tapping. In such a case the machine illustrated would be taken to the work. Where an isolated hole or two only are required, a pneumatic or electric drill would, of course, serve in many instances, but if the holes are numerous, and have to be drilled with great accuracy, a portable radial drilling machine of the form illustrated should show a considerable saving in labour charges and other advantages. In Messrs. Asquith's machine the column is bolted to a base mounted on a four-wheeled trolley, provided with guiding ways and a rack for longitudinal adjustment. The radial arm is made in two sections, one fitted to the column and capable of being swivelled in a vertical plane, and the other sliding in or out on the first, either under hand or power motion. The arm as a whole may be swung through a complete circle round the column and locked in any position, and can be raised or lowered either by hand or power. At its end, the drilling head is arranged to swivel to any angle. At the opposite end of the arm a 3 horse-power reversible electric motor is situated, which transmits power by belt to a gear-box at the drilling head end. The gear-box gives three speed changes, which are doubled in number by gearing in the drill head. The range of the six spindle speeds thus provided is from 41 to 300 revolutions per minute. The double gearing in the drill head provides a reverse motion when tapping, the tap being withdrawn at about three times the tapping speed. The spindle is provided with two rates of self-acting feed, namely, 160 and 260 cuts per inch.

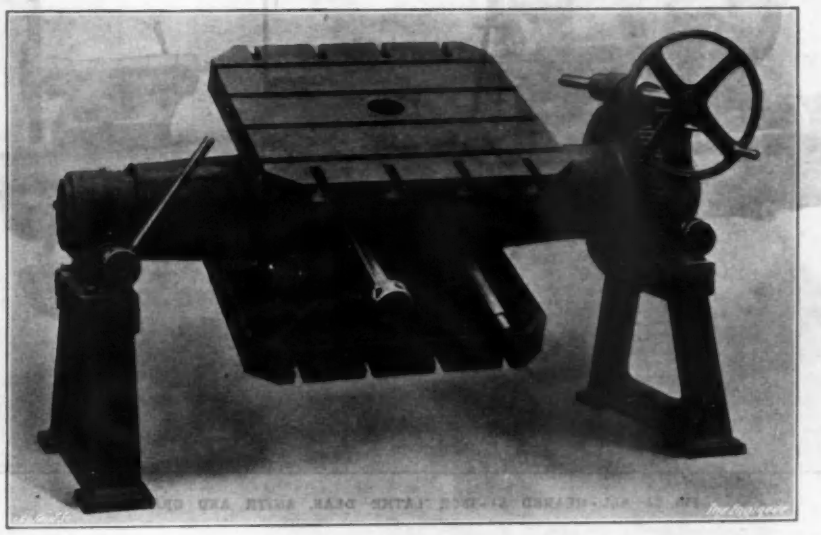

FIG. 41—TILTING TABLE FOR DRILLING MACHINES—ASQUITH

Both these machines are adapted for drilling holes at an angle, but in some of the other machines exhibited by Messrs. Asquith the same or similar facilities can be obtained by means of the patented tilting table, illustrated in Fig. 41. This table, as will be understood after a brief inspection of its

design, has additional advantages, not the least of which is the fact that it enables at one setting every face of a piece of work to be operated upon under a drilling machine, with the exception of that face actually bolted to the table. The fitment consists

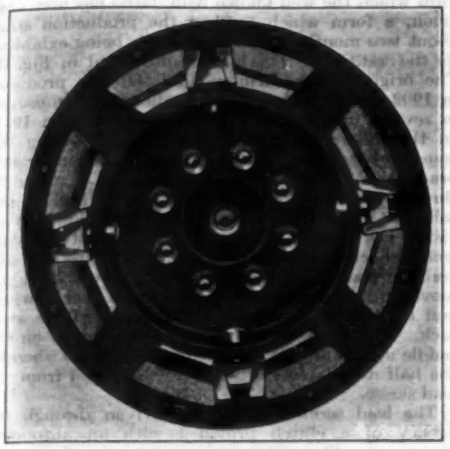

FIG. 42—SEGMENTAL GRINDING WHEEL

of two tee-slotted tables, mounted upon an axle, which may be rotated in either direction by means of worm gearing and a hand wheel. Each table, in addition, has a separate rotary motion about the central pivot, whereby it is attached to the axle.

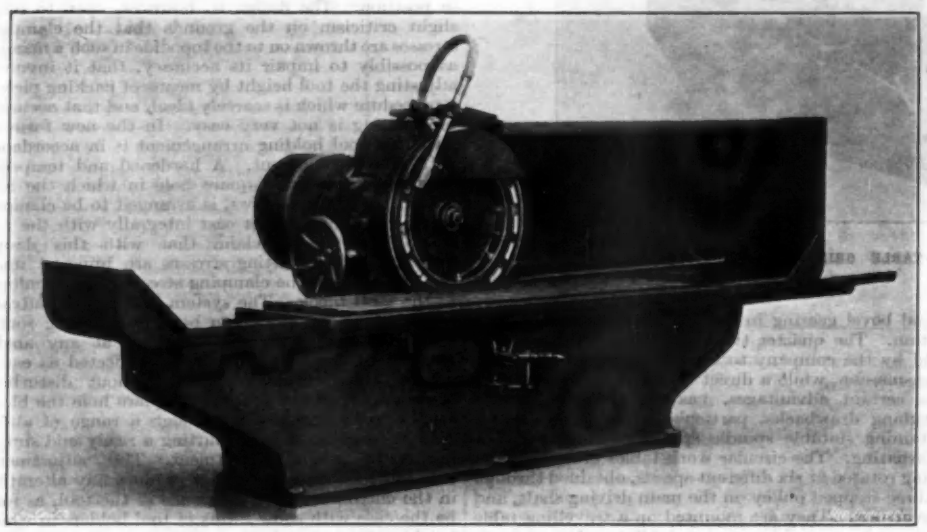

FIG. 43—HORIZONTAL SPINDLE SURFACE GRINDER—LUMSDEN

Both the motion of the axle and the motion of the tables are provided with indexing arrangements, and with stops at every 90 deg. or 45 deg. The fitment is made with tables measuring from 18in. to 48in. square or more.

THE LUMSDEN MACHINE COMPANY, LIMITED.

Since 1910 the Lumsden Machine Company, Limited, of Gateshead, has confined itself to the manufacture of grinding machines. In that year it produced its well-known oscillating tool grinder, and for a number of years, particularly during the war period, tool grinders and their development engaged its closest attention. Gauge and form tool grinding was also studied. After the war the firm proceeded to develop its machines in directions other than for tool grinding, for it believed, and believes, that the use of abrasives should become a primary method of machining surfaces in direct competition wherever the method is applicable with established types of metal-removing machines, using a cutting tool. At the Exhibition, besides various forms of tool grinders, the firm is showing several surface grinding machines designed to compete with machine tools. In the rapid production of machined surfaces by grinding from the rough state, the firm claims to be able to give some most remarkable results. It is scarcely content if it divides general machining times by six. First-class milling machine times, it states, have by the adoption of the alternative process of grinding been divided by six. With a 30in. segmental wheel of the type described below, it has, it claims, removed over 20 cubic inches of cast iron in a minute.

The segmental form of grinding wheel with which most of the firm's machines, other than the tool grinders, are fitted, is illustrated in Fig. 42. The design is, it is claimed, a material improvement on earlier forms of segmental wheels. The segmental construction providing, as it does, interruptions in the abrasive ring, assists in the discharge of the metal removed from the work, a factor which, it is held, is as essential in a grinding machine as in a machine tool of the ordinary cutting class. Another feature of the design lies in the fact that the cast steel frame of the wheel supports the abrasive close up to the cutting surface. The blocks are supported against a backing piece on the rear face of the wheel, and with this construction it is held the amount of metal removed can be increased for a decreased consumption of abrasive. In the fourth place, the construction is clearly such as to increase the operator's safety.

Among the machines exhibited which are fitted with segmental wheels is the horizontal spindle surface grinder, illustrated in Fig. 43. This machine carries a wheel, 30in. in diameter, and is in use producing flat surfaces on locomotive, textile and electrical machinery parts, and for other purposes for which its open-sided design renders it useful. The table has a working surface of 24in. by 84in., and is supported on the bed on one flat and one vee guiding surface. Cast solidly with the bed is a pedestal, to which the grinding wheel head is bolted. The segmental wheel is mounted on a heavy flanged steel spindle, running on ball and roller bearings, and provided with a thrust arrangement carried in a ram. The ram may be fed forward towards the work, either by means of a large hand wheel or by a self-acting feed, giving a movement of from 0.002in. to 0.01in. per stroke of the table. The machine is driven by a single pulley on the grinding wheel spindle. From the spindle power is taken to the work table through chain gearing, a drum pulley, open and crossed belts, a two-speed gear-box, a worm mounted on an oblique shaft, and a straight toothed rack mounted on the table. A centrifugal pump and a settling tank provide the water service, and both the wheel and the table are fitted with splash guards to protect the operator.

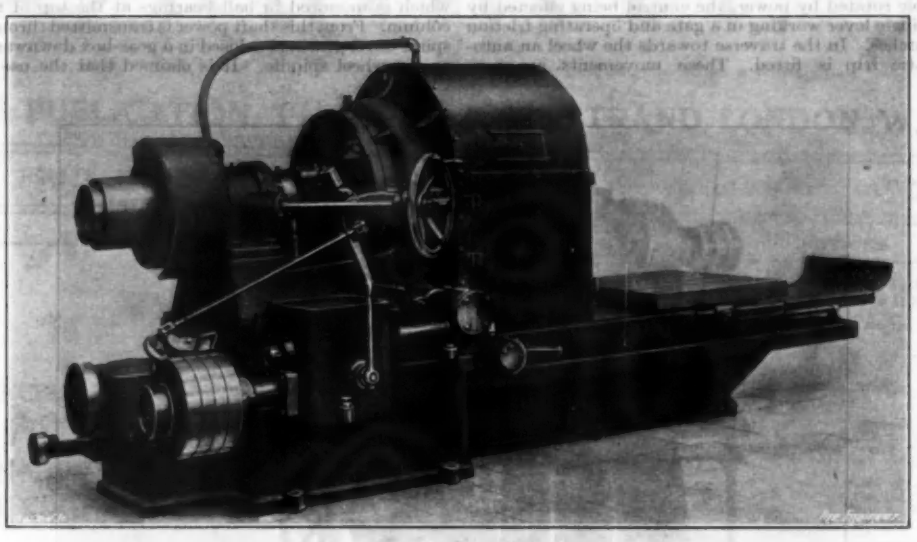

FIG 44—PLANETARY HEAD SURFACE GRINDER—LUMSDEN

An exceptionally interesting machine exhibited by the Lumsden Company is the planetary head surface grinder, represented in Figs. 44 and 45. This machine, the makers claim, introduces a new principle in surface grinding. The grinding wheel, again of the segmental type, in addition to revolving about its own spindle centre, executes a planetary movement about an axis passing through its circumference, so that a given size of wheel can cover an area of diameter twice as great as its own; that is to say, four times its own area. The advantage claimed for the planetary head lies, apart from increased efficiency, in the fact that a machine of relatively small size and cost can deal with work of unusual dimensions. In Fig. 45 the machine is illustrated at work on a motor casing, the four faces of which it can finish in a total time of 15 min. It is also being used on the casings of totally enclosed switch gear, and similar work, and in a double-headed form, for finishing the flange faces of pipes. The bed of the machine carries a saddle on one flat and one vee guide. On the saddle

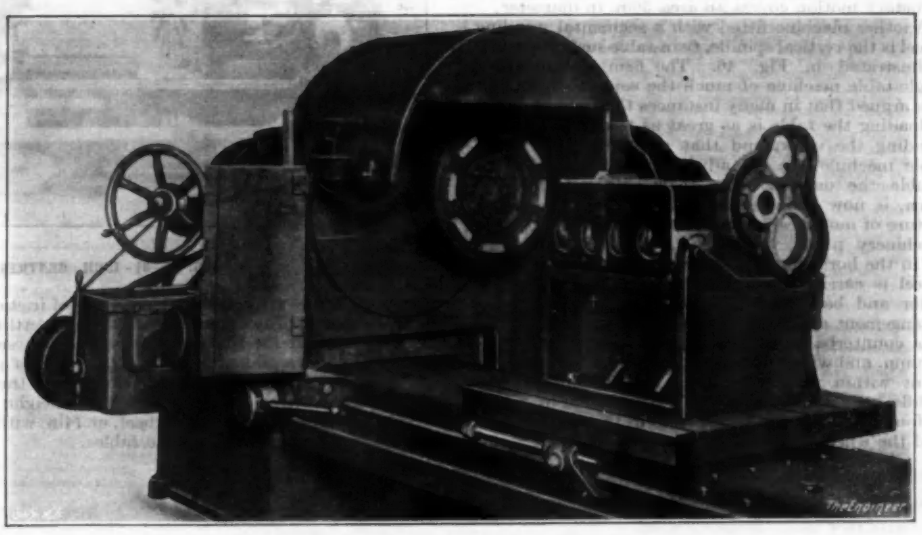

FIG. 45—PLANETARY HEAD SURFACE GRINDER—LUMSDEN

is mounted a tee-slotted square worktable, which can be stationed in any one of four right-angled positions by means of a plug working in steel bushed holes. The saddle can be traversed and the worktable rotated by power, the control being effected by a single lever working in a gate and operating friction clutches. In the traverse towards the wheel an automatic trip is fitted. These movements are provided solely for facilitating the setting up of the work. The feed motion is obtained by advancing the wheel towards the work. The planetary carrier is mounted within the headstock, and is driven by open and crossed belts through a gear-box giving two speeds of rotation, the final stage in the drive being through a worm and worm wheel. The carrier can either be driven continuously in one direction or oscillated through any desired arc of a circle by means of the open and crossed belts and tappets attached to a tee-slotted ring on the carrier. A heavy spiral spring acts against a plunger in the carrier for the purpose of taking up end wear. The segmental wheel is, as in the other machine, mounted on a flanged spindle carried in a cylindrical ram. This ram can be fed longitudinally by means of a screw operated from a hand wheel at the front of the headstock. The spindle is driven from the centre of the planetary carrier by means of single helical gear wheels. The machine exhibited has a wheel 18in. in diameter, which in its planetary motion covers an area 36in. in diameter.

Another machine fitted with a segmental grinding wheel is the vertical spindle, twin-table surface grinder—illustrated in Fig. 46. The firm also makes a single-table machine of much the same pattern, but it is argued that in many instances the time occupied in loading the table is as great as that consumed in grinding the work, and that consequently a twin-table machine has the advantage of being able to double the output. The twin-table machine, we learn, is now being successfully used in the manufacture of motor car cylinders and gear-boxes, textile machinery parts, valves and electrical switchgear. As in the horizontal-spindle machine, the segmental wheel is carried on a flanged spindle, mounted on roller and ball bearings, and fitted with a thrust arrangement attached to a ram. The ram is carried in a counterbalanced saddle, which is gibbed to the column, and which can be brought by a power movement within working distance of the tables. The saddle is thereupon clamped to the column by means of four bolts working in tee slots in the column face, and the wheel is fed on to the work by a self-acting motion applied through the ram. The total feed distance provided is 1¼in., and the feed rate can be varied through a wide range. The machine is driven from a single belt pulley on the main driving shaft, which is mounted in ball bearings at the top of the column. From this shaft power is transmitted through spiral bevel gearing enclosed in a gear-box downwards to the wheel spindle. It is claimed that the use of spiral bevel gearing in the spindle drive is an innovation. The quarter twist belt as an alternative is held by the company to be useless for heavy power transmission, while a direct motor drive, although it has certain advantages, has more than counterweighing drawbacks, particularly in the matter of obtaining suitable spindle speeds, if the current is alternating. The circular work tables are capable of being rotated at six different speeds, obtained through a three-stepped pulley on the main driving shaft, and a gear-box. They are mounted on a travelling table that can be moved by power on a flat and a vee guide on the bed. Both the rotary and traversing movements of the tables are controlled by means of friction clutches. A centrifugal pump and a large settling tank are provided for the water service. The segmental wheel has a diameter of 18in. The tables are 36in. in diameter, and at the Exhibition one of them is shown fitted with a magnetic chuck. A height of 18in. can be admitted under the wheel, or 14in. with a magnetic chuck in position on the tables.

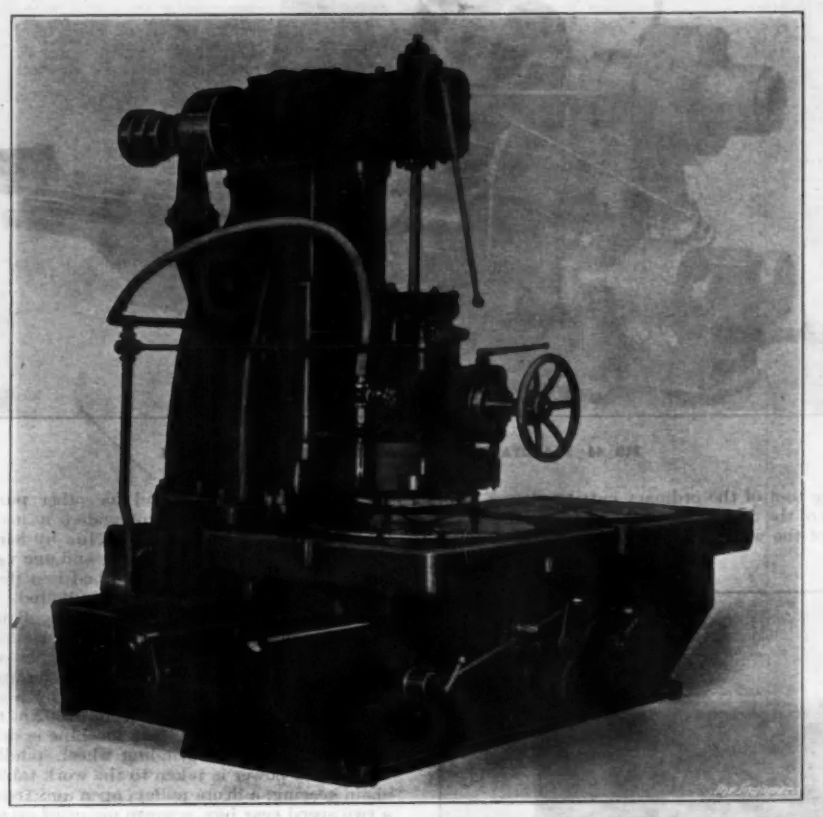

FIG. 46—VERTICAL SPINDLE TWIN-TABLE GRINDER—LUMSDEN

### DRUMMOND BROTHERS, LIMITED.

On the stand of Drummond Brothers, Limited, of Guildford, there is an extensive selection of the small machine tools and accessories for which this firm is famous; but chief interest is to be found in the new form which the well-known 3½in. lathe has now been given, a form which reached the production stage about two months ago, and which is being exhibited for the first time. This lathe is illustrated in Fig. 47. The original 3½in. Drummond lathe was produced in 1902, and has since been modified and improved in several important respects, particularly in 1912. In the different forms it has assumed during the course of its evolution it has been the invariable practice to transmit hand motion to the saddle through the lead screw from a hand wheel at the tailstock end of the bed. In the new design provision has been made for disconnecting the saddle from the lead screw by means of a dropping half nut and the transmission to the saddle of quick sliding movement through the agency of a hand wheel and a cut steel pinion, which engages with a steel rack. The hand wheel referred to is carried on the saddle apron, and to the left of it is a knob whereby the half nut is engaged with or disengaged from the lead screw.

The lead screw as before is driven through the agency of a clutch provided with an automatic throw-out. The adjustable stop whereby the throw-out is regulated is now arranged to butt against a small pad on the apron.

One of the most difficult features to provide in a small lathe is a perfectly satisfactory form of tool holder. In the earlier Drummond 3½in. lathes the tool holder comprised a tool block with a single clamping bolt and two set screws, and proved satisfactory, provided the block was secured to the top slide of the saddle before the tool itself was fixed in position. The design is, however, open to some slight criticism on the grounds that the clamping stresses are thrown on to the top slide in such a manner as possibly to impair its accuracy, that it involves adjusting the tool height by means of packing pieces, a procedure which is scarcely ideal, and that accurate tool setting is not very easy. In the new form of lathe the tool holding arrangement is in accordance with Norman's patent. A hardened and tempered steel block within a square hole in which the tool is held by two set screws, is arranged to be clamped on to a cylindrical post cast integrally with the top slide. The makers claim that with this design only the normal cutting stresses are imposed upon the top slide, all the clamping stresses being confined to the steel block. The system also has the advantage that as the block can be readily swung round on the central pillar and clamped at any angle, tool setting for boring purposes is effected as easily as for plain turning. Again, without disturbing the clamping of the tool in its square hole the block can be moved vertically through a range of about ⅜in. on the post, thus permitting a ready and simple means of height adjustment. This adjustment, it is to be observed, does not produce any alteration in the cutting angle or clearance of the tool, as may be the case with some forms of tool holders in which height adjustment is secured by means of packing pieces.

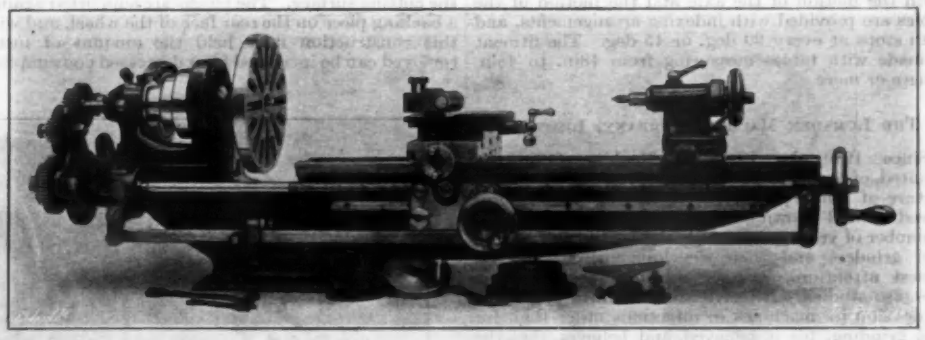

FIG. 47—3½-INCH CENTRES LATHE—DRUMMOND BROTHERS

The standard pattern of the new lathe has a bed 2ft. 8½in. in length. A form with a bed length of 3ft. 8½in., but otherwise identical with the standard design, is also made. It is the long bed form that, solely because of the clearness of detail in the original photograph, we have chosen to illustrate in Fig. 47. Both forms can be driven either by foot power or otherwise.